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Report of the 6th Expert Consultation on Indian Ocean Tunas

Colombo, Sri Lanka

25-29 September 1995

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INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME

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Colombo, 1995

TABLE OF CONTENTS

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The 6th Expert Consultation on Indian Ocean Tunas was held at the Taj Samudra Hotel in Colombo, Sri Lanka, 25 - 29 September, 1995. It was attended by 51 scientists from national institutions of 20 countries (Appendix I) and representatives of two Tuna Commissions, in addition to staff from the Food and Agriculture Organization (FAO) and the Indo-Pacific Tuna Managament and Development Programme (IPTP). During the course of the deliberations, 62 national reports and scientific papers were presented (Appendix II).

Opening of the Meeting

The Meeting was addressed by Mr. Henry Gunawardena, Chairman of the National Aquatic Resources Agency (NARA). In his address, he covered the historical development of tuna management in the Indian Ocean.

Mr. Tsukasa Kimoto, FAO Representative to Sri Lanka and the Maldives, then thanked Sri Lanka on behalf of the Director-General of FAO for having hosted this meeting.

Mr. David Ardill, Programme Co-ordinator of IPTP, gave an overview of the developments in the tuna fisheries in the Indian Ocean and of the institutional developments which are occurring. He emphasised that the participants to this meeting were expected to address the scientific issues and were here in a scientific capacity rather than as representatives of their governments.

The meeting was then opened by the Honourable Mr. Indika Gunawardena, Minister of Fisheries and Aquatic Resource Development of Sri Lanka, in the presence of guests from the Diplomatic Corps and of the Sri Lankan Government. In his speech (Appendix III), he emphasised the commitment of the Sri Lankan Government to regional co-operation in tuna management. Sri Lanka intends to develop its offshore fisheries, both domestic and through joint venture activities at an industrial level. Sri Lanka has hosted IPTP since the start of this programme’s activities in 1982, and he reiterated the offer to host the Indian Ocean Tuna Commission.

Election of Officers, Adoption of the Agenda and Arrangements for the Meeting

The Provisional Agenda prepared by the Secretariat was adopted without further discussion (Appendix V). The Chairman, Vice-Chairman, Discussion Leaders and Rapporteurs were appointed as follows:

1. Chairman of the Meeting
   Pauline Dayaratne

2. Vice Chairman
   Munesh Munbodh

3. Moderators and Rapporteurs of the Agenda Items

   Agenda Item 1: *Review of National Fisheries*
   Moderator: Alain Fonteneau
   Rapporteur: M.E. John

   Agenda Item 2: *Review of the Status of Stocks and Tuna Biology*
   Moderator: Gary Sakagawa
   Rapporteurs: Julio Morón and Michel Bertignac (yellowfin)
   Tom Nishida (bigeye)
   Renaud Pianet (skipjack)
   Albert Caton (albacore)
   Alejandro Anganuzzi (southern bluefin)
   Francis Marsac (swordfish)

Charles Anderson and Guido Carrara (other species)

Agenda Item 3: *Interactions and Tagging Studies*

Moderator: Antony Lewis
Rapporteur: Kim Stobberup

Agenda Item 4: *Progress Made in Data Collection*

Moderator: David Ardill
Rapporteur: Guido Carrara

Agenda Item 5: *Any other Matters, Conclusions and Recommendations*

Moderator: David Ardill
Rapporteur: Alejandro Anganuzzi

Agenda Item 1: *Review of National Fisheries*

Australia

Tuna fishing by Australian domestic vessels originally focused on pole-and-line fishing and later combined poling and purse seining for southern bluefin tuna. When the Australian Fishing Zone (AFZ) became operative in 1979, Japanese pelagic longlining in the area came under Australian control. Domestic interest in pelagic longlining gradually increased. At first this developed off eastern Australia where fresh-chilled yellowfin tuna were airfreighted to Japan. The fishery takes about 700 t of yellowfin a year. In the past year, domestic longlining activities have commenced off the west coast where bigeye and yellowfin tunas are the targets. Licensed Japanese longliners still operate around Australia under a bilateral agreement, but there has been progressive restriction of area of operation and effort.

The main impetus for the change to longlining resulted from introduction, then halving, of southern bluefin tuna quotas by Australia, New Zealand and Japan from the mid-1980s because of concern at the extent of reduction of the parental biomass and the resultant reduction in recruitment. Now, in keeping with a policy of directing activity away from small juvenile southern bluefin tuna (SBT), about half of the Australian 5,265t SBT quota is taken by longline. Australian-Japan joint venture longlining makes up most of the longline catch but there has been about 300 t taken in domestic small-vessel longlining off the east coast. Australian SBT surface fisheries on small juveniles concentrate on capture of fish off South Australia (SA) for cage-rearing (about 2,000 t), with about 500 t taken for immediate air-freight fresh-chilled to Japan

It was explained in discussion that purse seining of southern bluefin tuna for canning had ceased. Instead the vessels now purse-seine southern bluefin tuna for cage rearing, transferring live fish directly from the purse nets to towing cages by temporarily lacing them together.

British Indian Ocean Territory (Chagos Archipelago)

Fishing inside the 200 mile Fisheries Conservation and Management Zone (FCMZ) of the British Indian Ocean Territory (BIOT) has been dominated by distant water fishing nations. Longliners from Japan, Korea and Taiwan have fished in the area around the Chagos Archipelago for many years. Purse seine vessels have operated in the area since the early 1980s. Some records of driftnetting also exist prior to the ban on driftnetting in 1992.

The tuna fishery inside the zone is highly seasonal and highly variable. Longline vessels typically operate during two periods, June to September and November to February. Purse-seine vessels typically operate during a single period from November to February.

Reported longline activity in the zone has increased each year from 1991 to 1995. In 1994/95, 36 longline vessels were active in the FCMZ for a total of 882 days. Reported purse seine activity was low for 1991/92 and 1992/93. Between December 1993 and February 1994, 34 purse seine vessels were active for a total of 877 days, with a total catch of 31,719 t. Catches for the purse-seine vessels over this period averaged over 35 t per day. In the 1994/95 season, purse seine vessels spent only 133 days inside the zone and catches over this period averaged only 12.64 t per day. Longline catches are dominated by yellowfin and bigeye tunas, with a significant by catch of swordfish and marlins. Purse seine catches are dominated by yellowfin and skipjack tunas.

France

A) LA RÉUNION

During the last 5 years, a significant increase in catch has been observed in the three components of the fishery. In the artisanal fishery, boats use handlines in combination with troll lines, operating around 29 Fish Aggregating Devices (FADs) set near the island. The semi-artisanal fishery is mainly represented by longlining, targeting on swordfish. The species composition in weight for this fleet is swordfish 68%, albacore 15%, yellowfin 10% and other fishes 7%.

The industrial fishery allowed to operate in the EEZ of La Réunion outside 50 miles distance from the coastline consists of 28 Taiwanese longliners.

La Réunion is presently planning to further develop longlining. It, however, requires an improvement of specialised harbour supplies, manpower training, processing and marketing operations and a scientific and technical centre assisting regional development.

It was pointed out in discussion that heavy exploitation of swordfish in the Atlantic had resulted in a decrease in mean size in the fish caught, and that large quantities of small fish were discarded. This necessitated special attention to monitoring.

B) THE FRENCH TROPICAL PURSE SEINE FLEET

From the beginning of this fishery in the early 1980s, France has been one of the main fishing nations using industrial purse seiners in the Indian Ocean. The fleet operates in a wide area, covering the western side of the Indian Ocean, centred around the Seychelles Islands. Most of the catches are transhipped on board reefers in Victoria (Seychelles) and Antsiranana (Madagascar) harbours to their final destinations.

With 17-20 purse seiners, the French fleet has been stable since 1987 (with a slight shift towards larger boats), catches remaining between 75-100,000 t per year. They reached respectively 92,000 and 100,000 t in 1993 and 1994 (attaining in 1994 the level of the previous maximum observed in 1988), with a large proportion of yellowfin (40-50%), although the area covered (5°N-20°S, 40-75°E) had not significantly varied over the years. The fishery exploits both log and free swimming schools, (respectively 60% and 40% of the total catch). Catch-per-unti-effort (CPUE) remained high in 1993 and 1994 for both yellowfin and skipjack. The strong increase of the purse seiners' efficiency as well as the rapid development of fishing on FADs precludes any interpretation of these trends.

C) RESEARCH

French research in the Indian Ocean is conducted mainly by the *Institut Français de Recherche Scientifique pour le Développement en Coopération* (ORSTOM) which is based in Seychelles (Victoria, Seychelles Fishing Authority), La Réunion (Saint-Denis, SEAS laboratory and Le Port, IFREMER-*Institut français de recherche pour l'exploitation de la mer*) and Madagascar (Antsiranana, USTA).

Most of the studies conducted since 1991 were within the framework of the first and second Regional Tuna Projects, funded by the European Union (EU) through the *Association Thonière (Commission de l'Océan Indien*), whose activities (including fishery statistics, biology, oceanography, population dynamics, acoustic and traditional tagging and remote sensing) were described at the last meeting (1993). These studies are all conducted in close relationship with other similar studies done by ORSTOM in the Atlantic and Pacific Oceans, as well as with other international or regional tropical tuna organisations.

India

The fishery can be classified into coastal and oceanic fisheries. While pole-and-line and troll line fishing in the Lakshadweep sea and gillnet fishing around the mainland are the mainstay of the coastal tuna fishery, the oceanic fishery is by longlining, by chartered foreign vessels and Indian flag vessels. The fishery is currently undergoing a transition from fishing under charter schemes to fishing by Indian flag vessels. The number of chartered vessels has come down to 17 in 1994. Under the Indian ownership and joint venture schemes, 6 vessels of 42-55m overall length are currently in operation.

Annual production from the oceanic tuna fishery is of the order of 4,000 t (1993-1994), 65% of which is contributed by chartered vessels, 33.5% by Indian commercial vessels and 1.5% by government survey vessels. Yellowfin formed 46.5% of the catch, bigeye tuna 26.3%, billfishes 18.6% and sharks 8.6%. While yellowfin tuna is the major catch component of chartered vessels, the Indian owned vessels are targeting on bigeye tuna as well.

Research support includes tuna longline surveys, biological studies, particularly on yellowfin tuna, and environmental interaction studies.

Indonesia

The longline fishery developed remarkably in recent years, the fleet size reaching 423 domestic vessels and 508 foreign vessels in 1993. Yellowfin and bigeye tuna are the most important species contributing to the fishery. Major fishing grounds for the species are along the west coast of Sumatra, Java, Bali and Nusa Tenggara. The average hooking rate obtained for yellowfin and bigeye are 0.49 and 0.29 fish per 100 hooks, respectively.

Six research projects including studies on live bait are envisaged to be taken up in 1995-96. Data of foreign longliners are being collected .

It was indicated in discussion that Indonesian waters support substantial purse-seine operations in the Pacific region but only small-scale operations in the Indian Ocean region. The latter region, in contrast, is the main longline region.

Iran

Tuna fisheries in Iran consist of an artisanal fishery which contributed about 42,000 t and an industrial fishery which contributed about 12,000 t in 1994. The artisanal fishery consists of about 3,100 boats operating gillnets. Important species contributing to the fishery are yellowfin tuna, longtail tuna, skipjack and seerfishes. The industrial fishery consists of two purse seiners and 9 longliners. The average annual catches of purse seiners and longliners were 2,700 t and 380 t respectively during 1992-1994.

The purse seiners do not record the composition of catch. It was emphasised in the discussion that data collection needs to be streamlined, and there should be efforts to obtain information on species composition.

Japan

The Japanese longline fishery operates about 180 vessels in the Indian Ocean. Total effort in 1994 was 76 million hooks, which is only 60% of the peak effort in 1967 and 1985. Seasonal fluctuations have been observed in fishing effort which reflects on the distribution pattern, in time and area, of southern bluefin tuna. The catch from the longline fishery declined from a high of 2 million fish during the sixties to about 0.6 million fish (27,000 t) in 1994. The percentage of southern bluefin tuna in the total catch showed a declining trend, while those of albacore, bigeye and yellowfin showed an increasing trend.

The commercial purse seine fishing, which started with 10 vessels in 1991, has concentrated on the eastern Indian Ocean since 1993. This shift in fishing area is due to economic reasons rather than of resource availability . Both the effort and catch peaked in 1992 at 2,400 days and 45,000 t respectively, and decreased to 1,400 days and 25,000 t in 1994. A significant increase was observed in the percentage of bigeye tuna in purse seine catches in 1994. FADs are extensively used in fishing, 75% of total sets operated being on FAD-associated schools. In order to evaluate the implications of catch of smaller fish in the purse seine fishery, size frequency investigations (in Japanese ports) were started in 1994. Much of the catch is landed in foreign ports and could not be sampled by the programme.

In the discussions, the necessity of ensuring accuracy in the species composition and length frequency data in the purse seine fishery was emphasised. Observer programmes would be extremely useful in this direction. Further, it may be useful to compare the length frequency data from the Japanese fishery with data from the Seychelles fishery in order to confirm the representativeness of the port sampling. The Japanese could contact the Seychelles Fishing Authority (SFA) for their length-frequency data.

Korea

In 1957, the Korean tuna fishery began with one fishing vessel in the Indian Ocean. However, 50 Korean tuna longliners are operating now actively in the Indian Ocean, catching about 15,000 t of tunas, comprised of 47% bigeye, 36% yellowfin and 11% billfishes on the average. The decrease in total catch in recent years was attributed to a reduction in fleet size, and not due to any decline in CPUE.

Research on tuna fisheries and biology has been conducted by the National Fisheries Research and Development Agency (NFRDA). A tuna tagging project was started in 1993 and, from 1996, an observer program will be operated by the NFRDA to improve data collection for Korean fisheries statistics.

Madagascar

The first involvement of Madagascar in tuna fisheries was between 1972 and 1975. This pole-and-line fishery, based on Nosy-Bé, was not continued because of a fuel crisis in the industry at the time. However, during its short life, this fishery demonstrated that there was an exploitable resource.

The European tuna fleet moved to the Indian Ocean at the beginning of the 1980s and Madagascar, following the example of the Seychelles, signed a fisheries agreement in 1986 permitting these vessels to fish in the EEZ. Since that time, each new agreement has for a period of three years and permitted, respectively, 40 (1986) and 45 (1989) purse seiners, 42 purse seiners and 8 longliners (1992) and, finally, 40 purse seiners and 15 longliners (1995) to fish in the EEZ. The latest agreement was signed on 21 May, 1995.

In 1991, a similar agreement permitted 28 Asian longliners to exploit Malagasy waters. In 1992 and 1993, this figure dropped to 19 vessels, then rose to 68 in 1994. The tuna catch in the EEZ was 1,545 t in 1988, 8,510 t in 1989, 7,962 t in 1990, 8,000 t in 1991, 7,206 t in 1992 and 5,990 t in 1993.

The Statistical Unit in Antsiranana (USTA) has been in operation since 1993. Its work involves sampling, collecting transhipment statistics and plotting tuna catches on a chart. The USTA has reported an increase in activities in 1994, compared to 1993 (118 purse seiner visits, against 69).

The tuna cannery "*Pêche et Froid de l'Océan Indien*" started production of canned tuna and fishmeal in 1990. The planned capacity is to handle 50,000 t of raw material a year. In 1992, its turnover attained 36 billion FMG from 13,500 t of finished product.

Malaysia

The total recorded landings of the foreign vessels in Penang from 1993 to July 1995 was observed through the returned permit forms for landing or transhipment of fish given by the ship agents to the Department of Fisheries of Malaysia. Landings ranged from 436 t to 4,393 t per month during the period covered. Between 38 and 448 permits were issued during the period. Yellowfin tuna was the dominant species landed. The tuna longliners that land in Penang are generally small vessels averaging 50 GRT and are powered by engines of about 400 HP.

Sashimi-grade tuna are exported to Japan. Second-grade tuna are usually frozen and sold to local canneries or exported.

In the case of the Taiwanese vessels operating in Malaysian waters, the Taiwanese delegation informed that the catches are not reported to Taiwan. Hence, there is no double reporting.

Maldives

The Maldives has a large, traditional livebait pole-and-line fishery. The main species caught are skipjack and yellowfin, as well as frigate tuna, kawakawa and bigeye tuna. Catches have increased over the last decade to a record level of nearly 90,000 t in 1994. Despite this, there is some concern over skipjack catch rates and sizes - both of which have declined in recent years. Effects of oceanographic variations, including ENSO events, on tuna catch rates have been studied. Substantial quantities of rainbow runner and silky shark are taken as by-catch in the pole-and-line fishery. Livebait utilisation is high, with an estimated catch of 11,100 ± 2,800 t in 1993. The development efforts of the government of Maldives include a major FAD deployment programme and the expansion of tuna collecting and exporting facilities.

Mauritius

An artisanal fishery for tunas has developed, in recent years, around FADs. The total catch from this sector and the sports fisheries is estimated to be around 600 t per year. Although various attempts were made to develop a longline tuna fishery, these have not led to development of a sustained fishery. Purse seining which was initiated in 1979 with one vessel, has gradually developed. Mauritius now operates three purse seiners having a combined net tonnage of 2,000 t. The total catch landed in Mauritius in 1994 was 7,689 t. Tuna transhipments increased in the last few years and stood at 14,946 t in 1994.

Mauritius continues its participation in the regional tuna project of the *Commission de l'Océan Indien*. A British-Mauritian Fisheries Commission has been established between the United Kingdom and Mauritius since 1994 for purposes of conservation of fisheries resources. The Commission covers the Mauritian Exclusive Economic Zone (EEZ), the BIOT FCMZ (Chagos waters) and high seas in the area bounded by the equator, 25º S, 53º E and 77º E.

Pakistan

The tuna fishery of Pakistan, though still in a nascent stage can be categorised into the coastal and the oceanic fishery. The coastal fishery consists exclusively of small to medium sized wooden gillnetters. The oceanic fishery consists of large tuna longliners of Taiwanese origin, but now registered under Pakistan flag.

The main tuna species caught in Pakistani waters are yellowfin, skipjack, kawakawa, longtail and frigate tunas. In 1994, total catches of tuna and tuna-like species amounted to 19,405 t, as compared to 16,578 t in 1993. Seasonal variations occur, showing two prominent peak catching periods in a year. The highest catch rates were recorded in May 1994 at 150 kg/day/boat. A new tuna fishery policy is under consideration.

Seychelles

An average of 56 and 50 purse seiners were licensed to fish in the Seychelles EEZ in 1993 and 1994, respectively. The majority of the fleet was made up of vessels fishing under the European Union agreement. The number of vessels in the fishery declined in 1994 after the Japanese purse-seine fleet left the Western Indian Ocean.

The total catch of the international fleet landing in Seychelles for 1993 stood at 276,911 t and that for 1994 at 272,187 t. The catch included 53% yellowfin and 37% skipjack tunas. After rising steadily, from the beginning of the 1990s, fishing effort dropped from 14,368 days in 1993 to 12,196 days in 1994. This again reflects the withdrawal of the Japanese purse-seine fleet from the regional tuna fishery. Although fishing effort had dropped in 1994, the catch per unit effort in the same year reached a record level of 22.32 t/fishing day.

Port Victoria still remains the most important port for transhipment in the western Indian Ocean. However, the proportion of tuna (as a percentage of the total catch) that are transhipped through Port Victoria has been declining. In 1993 and 1994, only 68% and 63%, respectively, of the total western Indian Ocean catch were transhipped through Victoria.

In 1993, a total of 222 licences were issued to longliners from the Far East (149 individual vessels). In 1994, a total of 236 licences were issued (to 150 individual vessels). The longline fishery in and around the Seychelles EEZ is dominated by the Taiwanese, South Koreans and Japanese. Due to poor logbook returns, the catch for 1993 (29%) and 1994 (16%) has been calculated *pro rata* at 13,700 t and 14,500 t respectively. The catch rates, also calculated *pro rata* for 1993 and 1994 are 0.39 t/1,000 hooks and 0.35 t/1,000 hooks, respectively. The catch composition for the two years in review are 47% yellowfin, 41% bigeye and 9% billfish. Transhipment activity by longliners in Port Victoria is negligible.

In 1993, trials began to assess the feasibility of fishing swordfish in the Seychelles. Initial results were promising. Since then, a local entrepreneur has purchased four 17-metre vessels to pursue this fishery. The vessels are due to start operating by the end of 1995.

Spain

The Spanish purse seine fleet has been operating in the western Indian Ocean since 1984. During the last 4 years, the number of vessels has been more or less constant (17-19). The fleet started operating with a single base in Seychelles and was extended to Madagascar (1982) and Kenya (1992). The catch has been hovering around 100,000 t during the last four years. The current level of effort is about 4,500 fishing days per annum. The proportion of yellowfin tuna is quite variable, averaging 44% during 1984-1994. Skipjack is the second target species and accounts for about 52% on average. Bigeye tuna is occasionally caught and represents 3% of the catch. The albacore catch is very sporadic.

On the trend in CPUE, three stanzas were identified, most likely due to increase in efficiency rather than increase in abundance.

Under an Experimental Fishing Campaign financed by the European Union, a total of 5 Spanish longliners were fishing in the western Indian Ocean during 1993 and 1994 with swordfish as target species. The results were not encouraging due to smaller size of fish obtained.

The OEP has re-designed the Spanish sampling scheme for length and species composition. It covers all the transhipment bases used by the Spanish fleet. This scheme is implemented in collaboration with the SFA, ORSTOM and USTA.

In discussions, it emerged that the data available to IPTP needs reviewing, as IPTP's nominal catch data base is not consistent with the catch and effort data reported in TWS/95/1/21. The importance of sampling species composition was stressed, as it was indicated that the increased fishing in association with FADs since 1991 has resulted in changed composition of catch. It is also relevant that CPUE should be worked out separately with respect to effort on log and free schools. The ecological impact of discarding fish is currently under evaluation by a joint project from the European Union, implemented by the *Instituto Español de Oceanografía* (IEO) and ORSTOM, in both the Indian and Atlantic Oceans.

Sri Lanka

The tuna fisheries in Sri Lanka are undergoing significant changes with more fishing boats conducting multi-day fishing in offshore waters. There are around 1,200 multi-day boats conducting voyages of more than 10 days. Gillnets are used together with longlines, and this combination accounts for more than 95% of fishing effort. The total production of larger pelagics is in the region of 75,000 t, of which around 55,000 t is from offshore areas. The continuous expansion of the offshore fishing fleet and the extended area of operation has contributed to a rapid increase in production. The average catch rate of the tuna fishing boats has been around 200 kg/boat/night . The different species of tunas together contribute to around 50% of the larger pelagics catch. Almost 60% of the tuna catch is skipjack tuna, followed by 20% yellowfin tuna. Sharks and billfishes also contribute significantly to the fishery.

With the issue of permits to fishing companies to land the tuna catch of longliners operated in international waters, a few local boat owners have started conducting tuna longlining at 50-100m depths, targeting on large, deep swimming yellowfin and bigeye tuna. Recently, a resource survey using longlining has been commenced. The draft national fisheries plan places greater emphasis on oceanic fisheries development.

Tanzania

Tanzania has a small fishery for tunas and allied species. Catches occur in an artisanal gillnet fishery. The catch in 1993 was 1,662 t, consisting of 537 t of tunas, 531 t of swordfish and 594 t of seerfish.

Taiwan (Republic of China)

In 1994, a total of 250 Taiwanese deep longliners and 58 conventional longliners fished in the Indian Ocean. The size range of these deep longliners were: 1) about 50% greater than 700 GRT; 2) about 45% between 300-400 GRT; and 3) 5% were smaller than 300 GRT. All conventional longliners were in the 200-400 GRT size class. The 1994 catch was 79,936 t (including albacore 14,410 t, bigeye 23,990 t, yellowfin 34,270 t and swordfish 3700 t), which is 58,678 t less than in 1993 (138,614 t).

In 1993, the tuna catch statistics compiled from recovered logbooks were first checked and then raised to the actual amount of bigeye and yellowfin catch. The Taiwanese vessel landing records at Japanese fishing ports provided an essential basis for determination of the raising factor.

A research team has been organised since 1995 to tackle the improvement of recovery of catch and effort log books of the vessels which fished in the Indian Ocean.

A revised catch data compilation algorithm has been implemented since 1993 to adjust the Taiwanese catches compiled from recovered log books versus those landing records provided by Japanese fishing ports. Detailed amounts of tunas (bigeye, yellowfin, and southern bluefin in particular) landed by Taiwanese vessels at Japanese ports are thus easily cross-referenced for data compilation.

In the course of discussions, it was noted that, as a result of the great flexibility of the Taiwanese fleet, there is difficulty in separating the catch and effort data into a conventional and deep longline components. With regard to doubling of longline effort and catch during 1993, the Taiwanese stressed that 1993 was a year of extremely good catch rates and that the sudden rise compared to the previous years could be due to under-reporting in the earlier period.

Yemen

Tuna fishing in Yemen is confined to the artisanal sector. The catch of tunas and tuna-like fishes was of the order of 2,721 t (1989) consisting of yellowfin tuna (661 t), kawakawa (980 t), longtail tuna (149 t), skipjack (27 t) , small tunas (267 t), sailfish (191 t) and seerfish (446 t). The eastern part of the Gulf of Aden starting from Shuqra to the border of Oman and the area from Ras-Fartak to Socotra Island are the best fishing grounds.

Agenda Item 2: Review of Status of Stocks and Tuna Biology

Introduction

An impressive number of papers covering a wide spectrum of topics on Indian Ocean tunas and tuna-like species were presented during this 6th Expert Consultation. Most of the papers dealt with description of fisheries and with the biology of the various tuna and tuna-like species. Very few dealt with quantitative and statistical analyses of data for evaluating the condition of the Indian Ocean stocks and for determining the effects of fishing on the stocks. Furthermore, crucial data for conducting such analyses were not available and time and facilities were inadequate for performing such analyses during the Consultation. Therefore, the participants to the Consultation concentrated mainly on reviewing fisheries statistics and in drawing general conclusions concerning the status of the stocks from general knowledge and experience with stocks in other oceans.

Yellowfin tuna

The total yellowfin tuna catch from the Indian Ocean has been increasing since 1983 owing largely to development of the purse-seine fishery, and since 1991 owing to exceptional catches by the longline fishery (Figure YFT-1). In 1991 the total catch was 226,000 t of which 73,000 t was produced by the longliners (32%) and 112, 000 t by purse seiners (50%) . By 1993 the total catch increased to 350,000 t of which 149,000 t was produced by the longliners (43%) and 136,000 t, by purse seiners (39%).

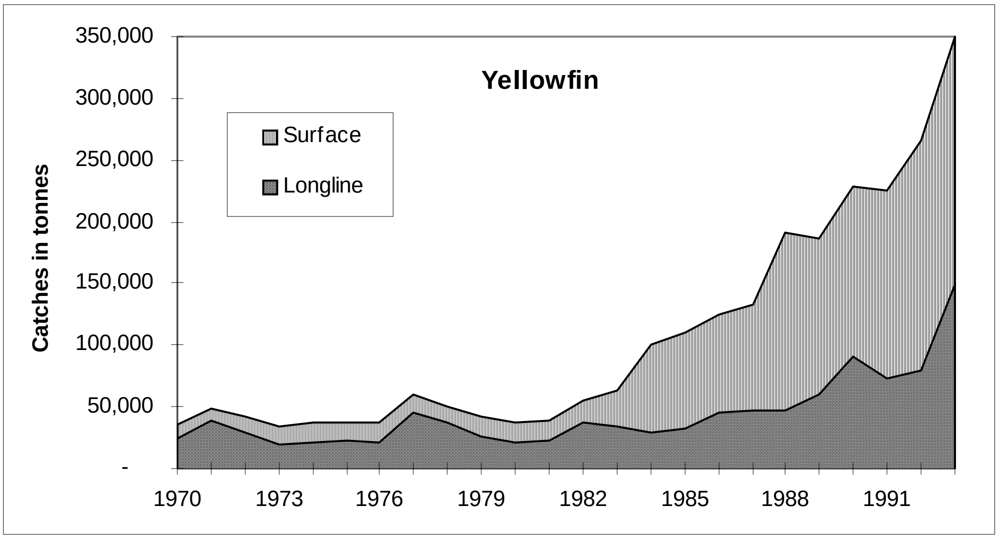

Figure YFT- 1. **Catches of yellowfin tuna by gear.**

RESEARCH ON FISHERIES AND BIOLOGY

A research project to validate age determination from otoliths and for estimating growth of yellowfin tuna was started in the Maldives (TWS/95/3/1). In August 1995, 737 juvenile yellowfin tuna were tetracycline-marked, tagged and released, and more such releases are planned for up-coming tagging cruises. Data from returns of these fish will contribute to understanding age and growth of yellowfin tuna.

A new length-weight relationship calculated from tuna landings in the Maldives was presented in TSW/95/2/9. The relation, $w=0.00002863\ FL^{2.897}$, was estimated from a size range of 25 cm to 145 cm FL yellowfin tuna.

The first results of a new programme for sampling the distribution of sizes of yellowfin tuna in the Maldives catch were presented in paper TSW/95/2/9. During 1994, the first year of the programme, over 74,000 yellowfin tuna were measured. Further work in processing to the national level statistics is in progress.

An estimate of annual instantaneous natural mortality (*M*) was presented in TSW/95/2/13. The method is based on a simple regression; $\hat{Z} = \hat{q}E + \hat{M}$, where $\hat{Z}$ was estimated using Heinke's method. The value obtained (0.8) is comparable to values reported in other studies.

Knowledge of the stock structure and especially the exchange rate of individuals between stocks of yellowfin tuna in the Indian ocean has long been recognised as important for conducting useful stock assessments. Tagging was suggested by past Consultations for studying yellowfin tuna movement and stock structure (see Appendix IV). This Consultation noted that tagging for a stock structure study would need to be conducted on a large scale (area and time) to be effective and the cost would be substantial and prohibitively expensive. The participants, therefore, explored alternative options, including scaled-down versions of a tagging program to study only some aspects of stock structure (see Appendix IV).The use of micro-constituents in hard parts for determining origin of individual fish was also reviewed as a promising technique for examining stock-structure hypotheses. The Consultation discussed its use for examining the hypothesis of separate eastern and western stocks of yellowfin tuna in the Indian Ocean. The Consultation recommended its use; however, noted that the technique is evolving and might still lack the resolution to reliably separate individuals and for estimating mixing rates.

Since the last meeting, progress has been made on evaluating fisheries performance in relation to environmental conditions. In TWS/95/2/8, the effects of El Niño Southern Oscillation (ENSO) events on the environmental conditions in the Indian Ocean and its relation to seasonal CPUE index of purse seiners were shown. Wind-stress patterns linked with ENSO events were similar in phase in the Indian and Pacific Oceans and opposite in phase in the Atlantic. Good correlation was observed between the thermal stratification index (TSI) of the water column and CPUE of adult yellowfin tuna, and a negative effect of wind-induced turbulence on the apparent abundance of juvenile yellowfin was identified. Since TSI is correlated to the ENSO signal, the linkage between the ENSO and the CPUE index of adult yellowfin tuna should be investigated to improve upon estimates of adult yellowfin abundance. The results of longlining surveys conducted in the Adaman Sea were described in TWS/95/2/7. There was good correlation between hook rates of yellowfin tuna and several environmental parameters (sea-surface temperature, mixed layer depth , thermocline depth and depth of the 18ºC isotherm) measured during the survey.

Preliminary results of a global review of tuna fisheries and its relation with the environment was presented in TWS/95/2/1. The analysis was recognised as important for understanding tuna fisheries and improving stock assessment. The Consultation noted that future analyses of this type could benefit from use of more precise time-area stratification of the data.

Results of sonic tagging experiments undertaken in La Réunion Island around FADs were presented in TWS/95/2/10. Seasonal trends affecting horizontal movements were described and vertical movements were analysed in order to provide a typology of tuna distribution according to features such as FAD association, time of the day, life stage, moon phase and thermal structure. Follow-on studies are planned to model the vertical distribution of tuna and local environmental factors in order to assess catchability.

Description of fisheries performance regarding gear efficiency, catchability and CPUE trends were presented in TWS/95/2/3, /4, /9, /11 and /15. The studies dealt primarily with processing fisheries data and estimating catch rates.

ANALYSIS OF STOCK CONDITION

Several CPUE indices and analysis of apparent abundance were presented. An increase in the CPUE of the pole-and-line fishery in the Maldives from 1990-1994 was linked to environmental conditions (TWS/95/2/9). Lower catch rates were traditionally observed in the fishery during the northeast monsoon. In recent years, however, CPUE has been greater during the northeast monsoon than during the southwest monsoon. It was speculated that this change with respect to the traditional pattern might be due to interaction with the purse-seine fishery operating in the western Indian Ocean, which would have caused lower catch rates during the SW monsoon.

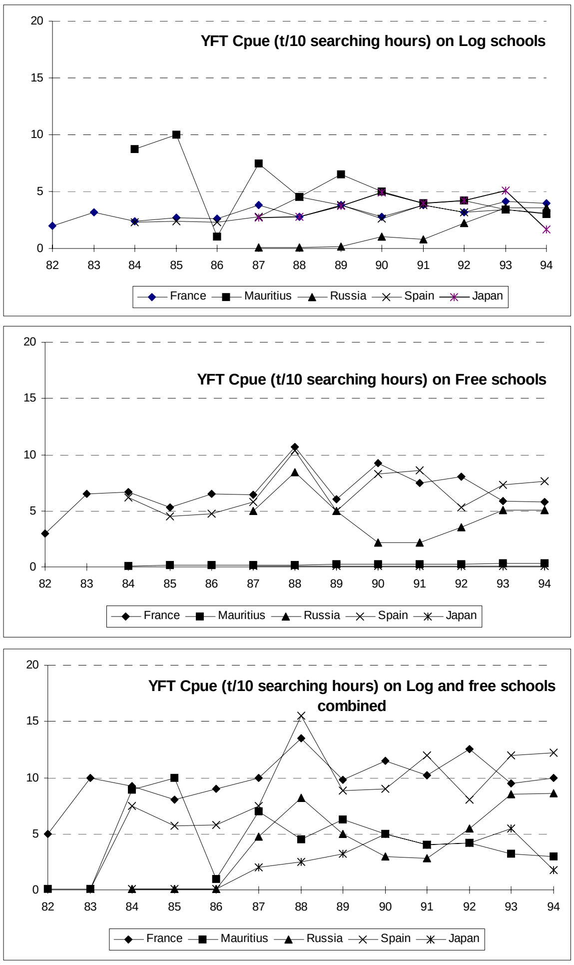

Figure YFT- 2. **Unstandardised CPUE from purse seiners in the western Indian Ocean.**

No major changes were reported in longline CPUE since the last meeting. There is a clear relationship between catch rates and the level of targeting on yellowfin tuna. Korean longliners have the highest catch rates as they target yellowfin; Japanese longliners are next, targeting both yellowfin and bigeye tunas (the latter with deep longline gear). Taiwanese longliners have traditionally target albacore and have the lowest yellowfin tuna CPUE on average, although in recent years they have also targeted yellowfin, primarily in the northern Arabian Sea. After standardisation, the CPUE trends indicate constant yellowfin tuna apparent abundance, even during the period of substantial catches by the purse seine fishery. An analysis of the local impact of the purse seine fishery development on the longline CPUE was presented in TWS/95/2/14. The study concluded that, in the heavily fished area of the purse seiners, negative impacts on the longline catch rates can be observed, together with changes in the length distribution.

CPUE of purse seiners has been higher for free-swimming schools than for log schools (Figure YFT-2). The overall trend of the CPUE has been stable for recent years and there is no clear trend in the distribution of age classes in the catches (Figure YFT-3). However, these CPUEs were felt to be poor measures of yellowfin abundance because they have not been adjusted for changes in efficiency of purse seiners. It was recommended that research be carried out on ways to make the adjustment and to identify relevant parameters that might relate to changes in the efficiency of purse seiners.

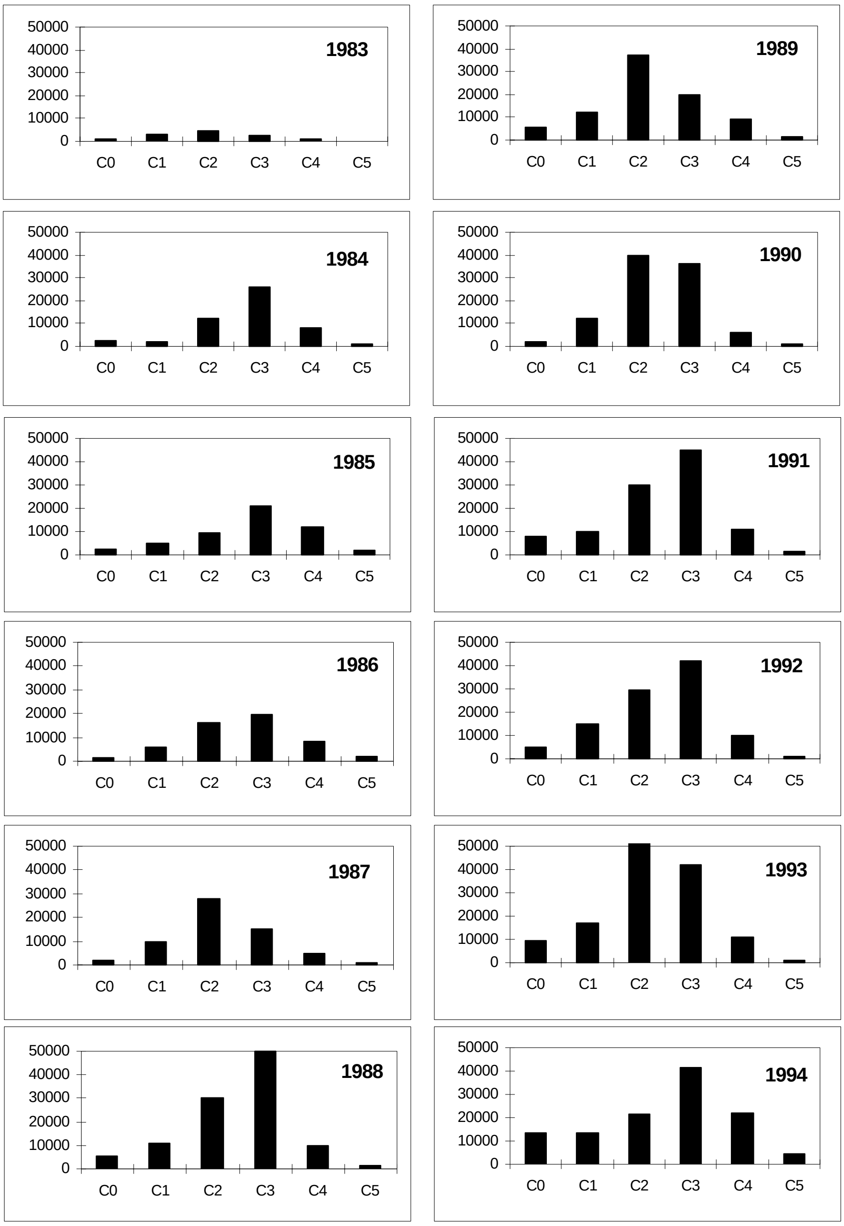

Figure YFT-3. **Age distribution in the catches of purse seiners in the western Indian Ocean**

Results of an analysis using an age-structured model were presented (TWS/95/2/13) that suggests a low exploitation rate for yellowfin in the western Indian Ocean. The results were considered preliminary because the model was calibrated with standardised longline CPUEs as representing adult abundance. However, the longline CPUE, as it has been the case in other yellowfin tuna fisheries in the world, does not seem to measure well changes in relative abundance. Furthermore, there might still be problems related to the parameter estimation that resulted in large uncertainties in the results.

Production model analyses using total yellowfin tuna catch and nominal fishing effort from the CPUE of purse seiners (Figure YFT-4) were performed during the meeting. The data lack sufficient contrast to estimate maximum sustainable yield (MSY) reliably and were not adjusted for improved efficiency of the purse seiners. Alternative calculations were done, adjusting for hypothetical increases in efficiency of the fishing effort. The results show that, if we assume an yearly increase of eight percent in fishing efficiency, there would be more definition in the data. Under this scenario, a production model analysis would suggest that the stock is over-exploited. This exercise demonstrates that, during a period of increasing efficiency in the fishery, production model analysis could provide erroneous results unless changes in efficiency were precisely accounted for.

STATUS OF THE STOCK

The structure and the status of the yellowfin tuna stock or stocks in the Indian Ocean is largely uncertain. If in the western part there is a stock largely separated from the one in the eastern part, then the current high level of fishing in the western part is likely in the range of moderate to above the level for MSY from the stock; hence, caution is advised with respect to increase in fishing intensity in the western Indian Ocean. On the other hand, if there is only one Indian Ocean-wide stock, then the current level of fishing is moderate but probably not in the range that adversely affects the stock. In this respect, it must be noted that the existing indicators of the status of the stock (CPUE, range of the fishery, age structure of the catches) do not suggest immediate problems.

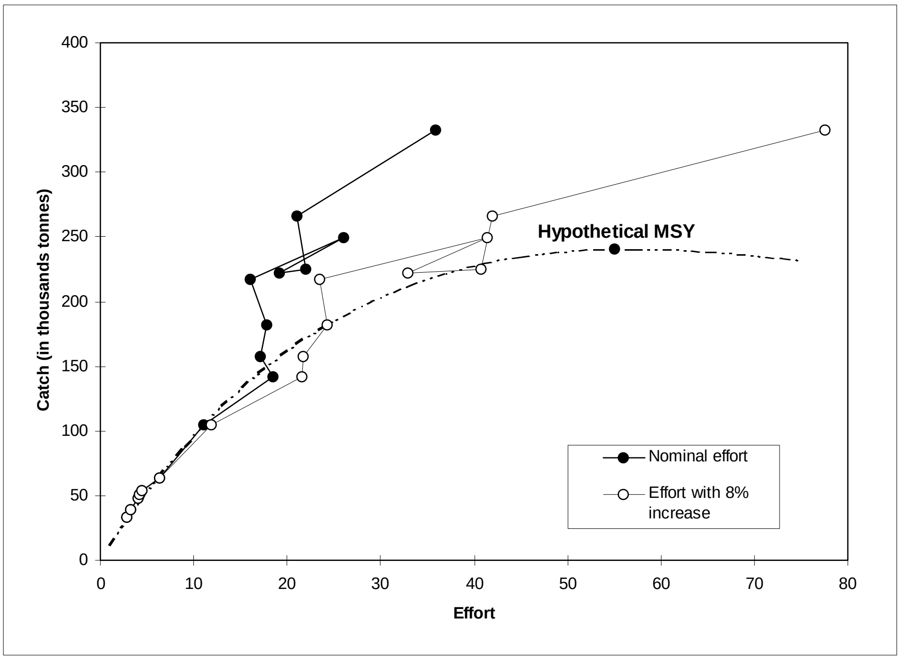

Figure YFT- 4**. Illustration of the potential consequences of a hypothetical increase in efficiency of 8% per year.**

RESEARCH RECOMMENDATIONS

1. Further studies are needed to adjust current indices of abundance from purse-seine vessels according to recent increases in fishing efficiency.
2. The data necessary for analysis using an age-structured model should be compiled and such an analysis should be carried out as soon as possible[1]. In particular, the data concerning length-frequency distributions of longline catches need to be compiled (this information has not been updated since 1988-1989). Before incorporating longline CPUE in the tuning of an age-structured model, it is necessary to further investigate its validity. In particular, data showing a recent, large increase in Taiwanese catches should be verified.
3. In the eastern Indian Ocean, the catch has also increased markedly after 1988, but has stabilised recently. This growth has been primarily due to the expansion of longline fishing in the region. Data available from this fishery are incomplete. An improvement in collection and reporting of fisheries statistics and biological information is required if a reliable yellowfin abundance index is to be developed for the region.

[1] For a previous analysis, see the Report of the Workshop on Stock Assessment of Yellowfin Tuna in the Indian Ocean, 7-12 October 1991, Colombo, Sri Lanka, 90pp. IPTP/92/GEN/20.

Bigeye tuna

A figure summarising surface and longline bigeye tuna catches in the Indian Ocean in recent years is included for reference (Figure BET-1). The figure suggests that longline catches have shown no trends in recent years, and have fluctuated between 40,000 and 50,000 t. However, there is a trend towards increasing catches of bigeye tuna by the surface fishery (between 10,000 and 15,000 t in recent years). This component is likely to persist or even increase because of the increased purse-seine fishing on logs and FADs.

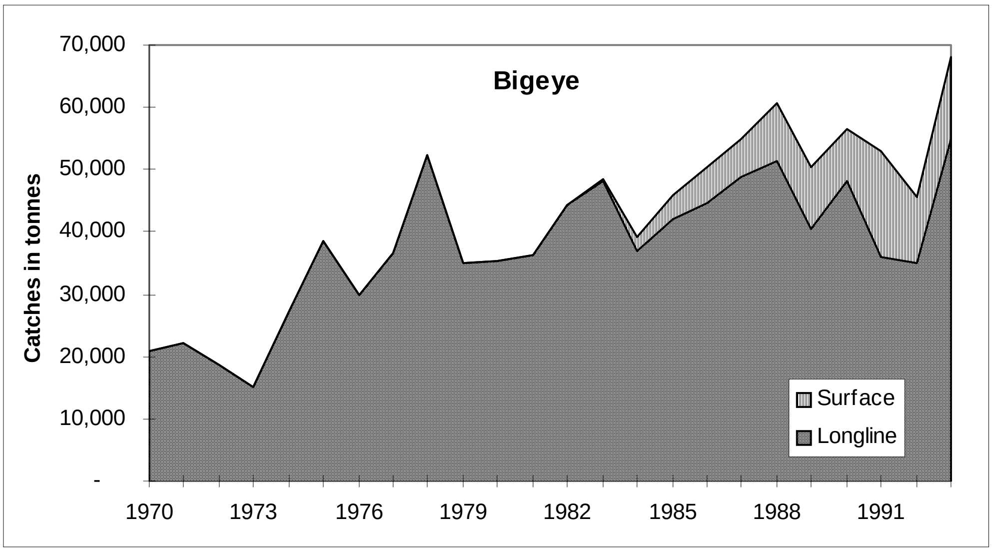

Figure BET-1. **Catches of bigeye tuna by gear.**

RESEARCH ON FISHERIES AND BIOLOGY

A review of the bigeye tuna in the Maldives was presented in TWS/95/2/16. Bigeye tuna is not recorded separately in the Maldivian catch statistics, but it is lumped together with yellowfin tuna. Sampling throughout the Maldives suggests that bigeye tuna is much more common in the southern area of the country than in the northern and central areas. The difficulties in correctly identifying bigeye tuna by external characteristics were discussed. In the Maldives, fish being processed in the cannery can be examined internally, and therefore species identification is not problematic. During tagging cruises, bigeye tuna can be easily identified as well because of the fresh condition of the fish caught. However, in the Malé fish market, it becomes more difficult to obtain a reliable species identification using external characteristics. Fish are expensive and it is not possible to buy large samples to estimate species composition using internal characteristics (by inspecting the liver).Therefore, the species composition estimated at the Malé fish market is probably biased towards yellowfin tuna.

The difference between the situations in Sri Lanka and Maldives were discussed. In the gillnet fisheries in Sri Lanka, the identification of bigeye tuna by external characteristics is not possible because fish is kept on ice and are not in good enough condition for identification at the landing port. It was mentioned that extensive and comprehensive species composition sampling has been conducted in most Indian Ocean purse-seine tuna fleets since 1987. This allows good estimates of both the quantities and size of bigeye tuna taken by the purse seiners (most often small sizes are not reported in the logbooks).

Table BET-1. **Estimated percentages of bigeye tuna in the catches of *Thunnus* in Maldives**

Area	Percentage in number	Percentage in weight
North and Center	1.3%	0.6%
South	14.7%	15.8%

Entire Maldives	4.6%	3.8%

A new species identification technique based on examining the tail, in use in the Pacific, was mentioned. Unfortunately, this technique is only useful for identifying larger (> 50cm) bigeye tuna from yellowfin tuna.

The percentages of bigeye tuna in Maldivian catches of *Thunnus* in 1994 are shown in Table BET-1. This pattern is similar to the one observed in the western Pacific region.

ANALYSIS OF STOCK CONDITION

CPUE trends of bigeye caught by the Japanese longline fishery, standardised by using a general linear model (GLM), were introduced in TWS/95/2/17. This analysis used catch, effort and auxiliary data in order to estimate actual trends in relative abundance of the population. In the model, terms were included for Area, Gear and the CPUE of another tuna and tuna-like species (YFT: yellowfin, SWO: swordfish, SBT: southern bluefin tuna, and BIL: billfish) were included. The GLM analyses were done separately using two data sets: 1) from 1952 to 1976 (excluding data on number of branch lines per basket) and from 1975 to 1994 (including dataon number of branch lines per basket). In the GLM analysis for the first data set Area, YFT, SWO and BIL showed large effects. For the second data set Area, Gear, SBT, SWO and BIL were the most important effects. Among the species introduced in the analysis, bigeye tuna showed a negative correlation with SBT, while YFT, SWO, and BIL showed positive correlations. Both the standardised and nominal CPUEs showed declining trends, but the nominal CPUE decreased much faster than the standardised CPUE during the period 1952-1976. In contrast, the GLM results using data from the period 1975-1994 showed a stable or slightly decreasing trend, while nominal CPUE suggested an increasing trend.

Using the standardised longline CPUEs as abundance indices, the parameters of a Schaefer production model were fitted (using the programme ASPIC) to assess the productivity and status of the bigeye tuna stock. By using different combinations of input data and constraints on parameter values different scenarios were obtained where the maximum sustainable yield (MSY) estimates ranged from 32,000 t to 77,000 t. The estimated ratio between the current biomass and the biomass at MSY was always around or above one. On the other hand, the ratio of current fishing mortality to the fishing mortality at MSY exceeded 1.0 when a penalty term was applied where estimates of initial biomass exceeded the estimated carrying capacity. In the latter case, the estimated MSY was in the range of 32,000-35,000 t.

According to results and depending on the MSY estimates obtained in the different scenarios, recent catches of bigeye tuna in the Indian Ocean were approximately at the MSY level or above the MSY. In general, the trends in the abundance indices suggest a stable population size, in spite of the recent increases in exploitation.

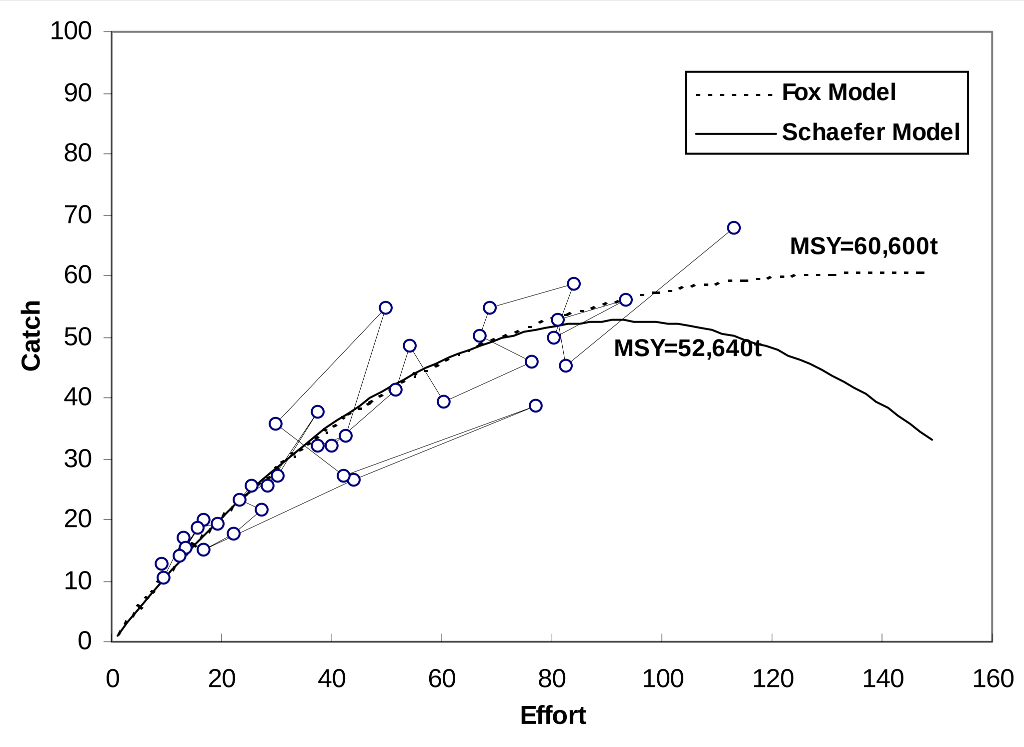

Figure BET-2. **Comparison of the results from different production models fitted to bigeye tuna data.**

Several technical points concerning the analysis were raised by the participants. It was noted that the scenarios that used only longline catch data as input should be viewed with caution, considering that there has been significant purse-seine catches in the recent past. On the other hand, if only the results that are based on the total catch are considered, then there is indication that MSY tends to be underestimated when data from the period 1952-1994 are used. This conclusion comes from a comparison of the average catch (which have exceeded 40,000 t in almost every year since 1981) with estimates of MSY that are in the range of 32,000-45,000 t. When only the data from the period 1961-1994 are used in the analysis, then the conclusion is that the catches have been at the level of MSY, with the possible exception of 1993-1994.

Some doubts were also raised regarding the data for the Taiwanese longline vessels, which showed a doubling of the catches between 1992 and 1993. In this respect, it was noted that 1993 was the first year in which estimates of Taiwanese longline catch involved weighting on the basis of Japanese tuna imports from Taiwanese vessels.

Some additional work on application of production models to the bigeye tuna was carried out during the Consultation and the results presented to the participants. On the basis of the same data used in the ASPIC analyses, MSY was re-estimated by the programme PRODFIT. The procedure to estimate the parameters in PRODFIT assumes that the population will reach an equilibrium when the level of fishing effort mortality is kept constant, and tries to estimate this equilibrium curve of the stock productivity, using the duration of the exploited life of the fish. In addition, PRODFIT can estimate the parameters of a Fox model, which assumes that the CPUE (at equilibrium) declines exponentially with increasing effort. By contrast, the Schaefer model assumes that such relationship is linear. The results of these alternatives analyses are shown in Figure BET-2. They suggest an MSY between 52,000 and 60,000 t.

Some of the problems shared by all the analyses based on production models were discussed by the participants. One of the characteristics of the data is that there is no decline in the catches with increases of effort. In these cases, it is impossible to reliably estimate MSY and it is likely that confidence intervals around the different MSY estimates obtained would largely overlap. In general, it is not until the population has been over-exploited that there will be information in the data to better identify the MSY range. Furthermore, production models assume an age-specific pattern of exploitation that is constant over time. The recent increases in the catches from the surface fishery, where the bigeye tuna caught are smaller than in the longline fishery, suggest this is not the case.

It was also noted that the pattern of the catch and effort data, where catches approach an asymptotic value as effort increases, is quite typical of the various bigeye tuna worldwide; similar patterns have been observed in the Atlantic, Pacific and Indian Oceans.

STATUS OF THE STOCK

The status of the bigeye tuna stock of the Indian Ocean is currently uncertain. Although recent increases in catches of adults by longliners and juveniles by purse seiners are unprecedented, nominal CPUE appears to be increasing or stable, which suggests that the immediate effects on the stock have not been adverse. Expanded monitoring and research will be required to determine the long-term effects.

RECOMMENDATIONS

1. The statistical problem of obtaining a good estimation of the species composition of the catch by purse seiners should be analysed. More samples from the Maldivian fisheries can be used to estimate species composition in the waters from 2-4° N.
2. Continue work on the status of the stock using different stock assessment methods such as age-structured models.
3. Confirm the large 1993 increase in bigeye tuna catch by the Taiwanese fleet.

Skipjack tuna

Recent catches by main gears are shown in Figure SKJ-1. After a dramatic increase due to the rapid development of the purse seine fishery in the beginning of the eighties, the total catch has been stable at about 250,000 t since 1989, divided into approximately equal proportions between the purse seiners (45-50%) and the artisanal pole-and-line, driftnet and troll-line fisheries (Maldives, Sri Lanka, India and Indonesia, 50-55%).

RESEARCH ON FISHERIES AND BIOLOGY

Several documents dealing with skipjack tuna biology (TWS/95/2/21, 22, 23, 24) and different fisheries (TWS/95/1/11, 12, 21, 24) were presented, as well as a description of the Maldivian fishery (TWS/95/2/18).

A growth study was presented (TWS/95/2/21) that used micro-increment deposition on the otoliths of skipjack tagged, injected with oxy-tetracycline (OTC) and recovered by the Maldivian tagging programme. The results were disappointing because they showed that the rate of deposition of increments is inconsistent between fishes, showing in all cases a deposition of less than one increment per day. In spite of the small sample size (8 fish), it was agreed that there is enough evidence to conclude that this methodology is not suitable for skipjack age determination. This result is consistent with findings from other studies in the Atlantic and Pacific oceans and it was suggested that this may be due to the fact that most of the fish analysed were sexually mature.

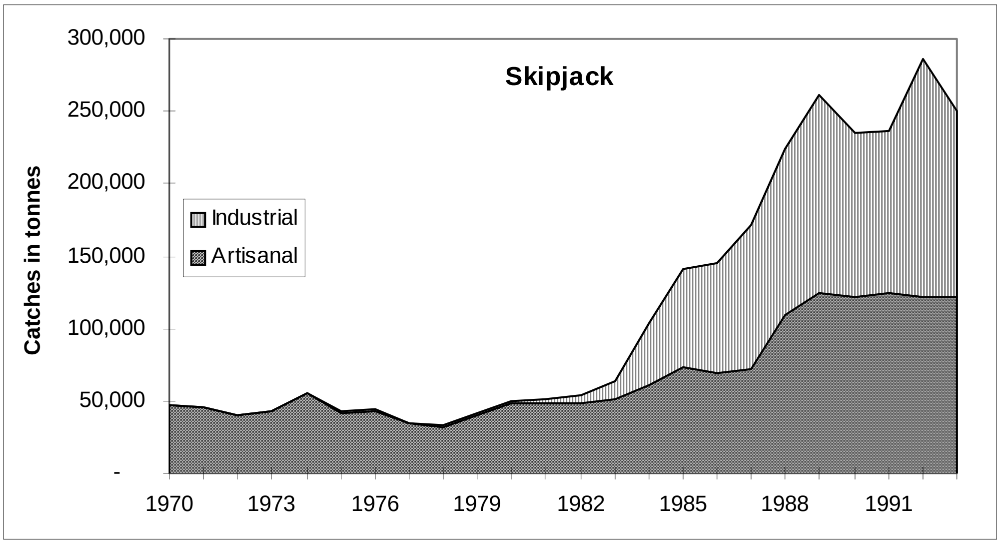

Figure SKJ-1. **Catches of skipjack tuna by fishery.**

This OTC study has shown that otoliths cannot be used for ageing studies and modal progression and tagging studies have also failed to produce robust estimates of growth rates. Estimation of skipjack growth rates appears to present major difficulties, as reported in TWS/95/2/18. This demonstrates the necessity of developing new methodologies that would allow an accurate estimate of skipjack growth. Tagging might be the best approach in this case to study time and space variability of growth.

A study on skipjack fecundity in the western Indian Ocean was presented in TWS/95/2/22. The conclusions indicated that skipjack tuna fecundity is constant across areas, ranging from 80,000 (at 44 cm) to 1.25 million (at 75 cm) eggs, or approximately 40-130 eggs/g of body weight. Spawning occurs all year long, but its intensity may vary seasonally within an area. This is consistent with the opportunistic spawning strategy characteristic of the species, that spawns everywhere it encounters water temperatures above 25ºC.

The sexual cycle of skipjack tuna in the western Indian Ocean, using data obtained from purse seine samples, was described in TWS/95/2/23. The monthly variations in the proportion of the different stages of gonad maturation indicated that, irrespective of the month, some 70% of the females have ovaries in an advanced stage of maturation. This percentage is minimum during July and August, corresponding to the core of the south-east monsoon. Size at first maturity is 41-42 cm for females and 42-43 cm for males (about 1.5 years old). The sex ratio is 1:1 for the whole Indian Ocean, but with some geographical variations related with the sexual cycle.

The skipjack sexual cycle was also described in TWS/95/2/24, in this case analysing longline and purse seine samples of fish ranging from 31 to 92 cm. The characteristics of ovogenesis were described and the fecundity assessed at 0.9-2.8 millions eggs for fish 52-69 cm long. Two peaks of reproductive activity were observed (from April to June and from November to January), although spawning occurs all year round. The overall sex-ratio was estimated at 1.08:1 for the whole Indian Ocean, with an increasing number of males after 70 cm. No females over 86 cm were observed. First spawning was observed to occur at 40 cm for females, and at 39 cm for males, with estimated sizes at first maturity (when 50% of the fish are mature) estimated at 43 and 40 cm respectively.

The results from these different studies were consistent, and tend to confirm most of the studies previously done in the Indian Ocean.

ANALYSIS OF THE STOCK CONDITION

Descriptions of various fleets fishing skipjack tuna can be found in TWS/95/1/11 (Mauritian purse seine fishery); TWS/95/1/12 (Sri Lankan gillnet fishery); TWS/95/1/21 (Spanish fleet) and TWS/95/1/24 (for purse seine vessels based in Seychelles or those whose activities are followed by the SFA).

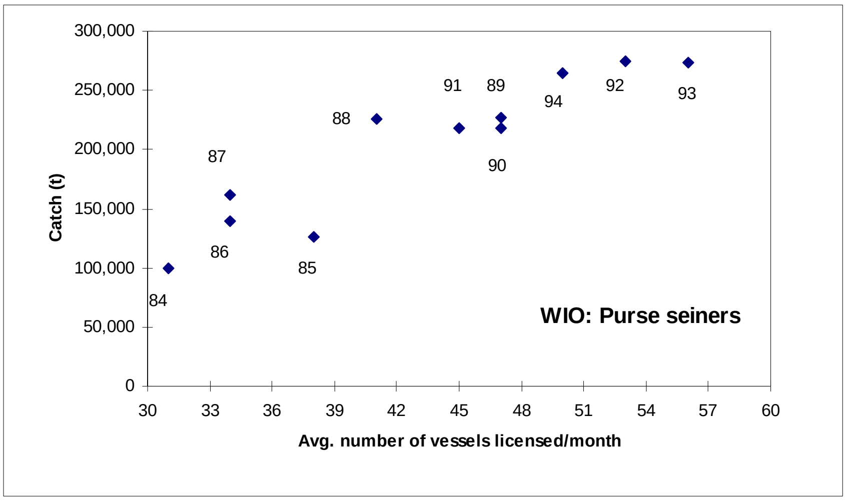

Figure SKJ-2**. Annual catch as a function of the average number of vessels licensed per month by the SFA.**

Purse seine activity remains at a high but stable level, as shown by Figure SKJ-2, which was extracted from document TWS/95/1/24. CPUE trends from the different purse seine fleets were also presented for log-associated and free-swimming schools separated and combined (Figure SKJ-3). The size composition also remains relatively stable, ranging from 35 to 65 cm, the majority of the catch being in the 40-55 cm range (Figure SKJ-4, taken from TWS/95/1/21). Because total catch (all species combined) for the surface fishery has been relatively stable since 1991 and skipjack tuna are largely taken in log or FAD sets in the Indian Ocean, the proportion of skipjack in the catch appears to be dependent on the availability of log schools and usage of FADS. In recent years, the practice of using FADs; and log has increased, probably in response to economic forces.

A synthesis of the evolution of the Maldivian pole-and-line fishery since 1970 was presented in TWS/95/2/18. All the boats are now mechanised, and the total skipjack catch reached 70,000 t in 1994, this increase being partly due to an increase of the effort. The CPUE series exhibited some decline while the catch was stagnating from 1988 to 1993, and returned to their previous values in 1994. This phenomenon is linked to a decrease in the average weight of the fish. Despite the relative recovery in 1994, this decline is still cause for concern in the Maldives. Several possible explanations were mentioned: changes in environmental conditions, an increase in the local competition between fishing vessels, and the influence of the purse seine fishery. It might also be possible that Maldivian fishery is approaching a local MSY level.

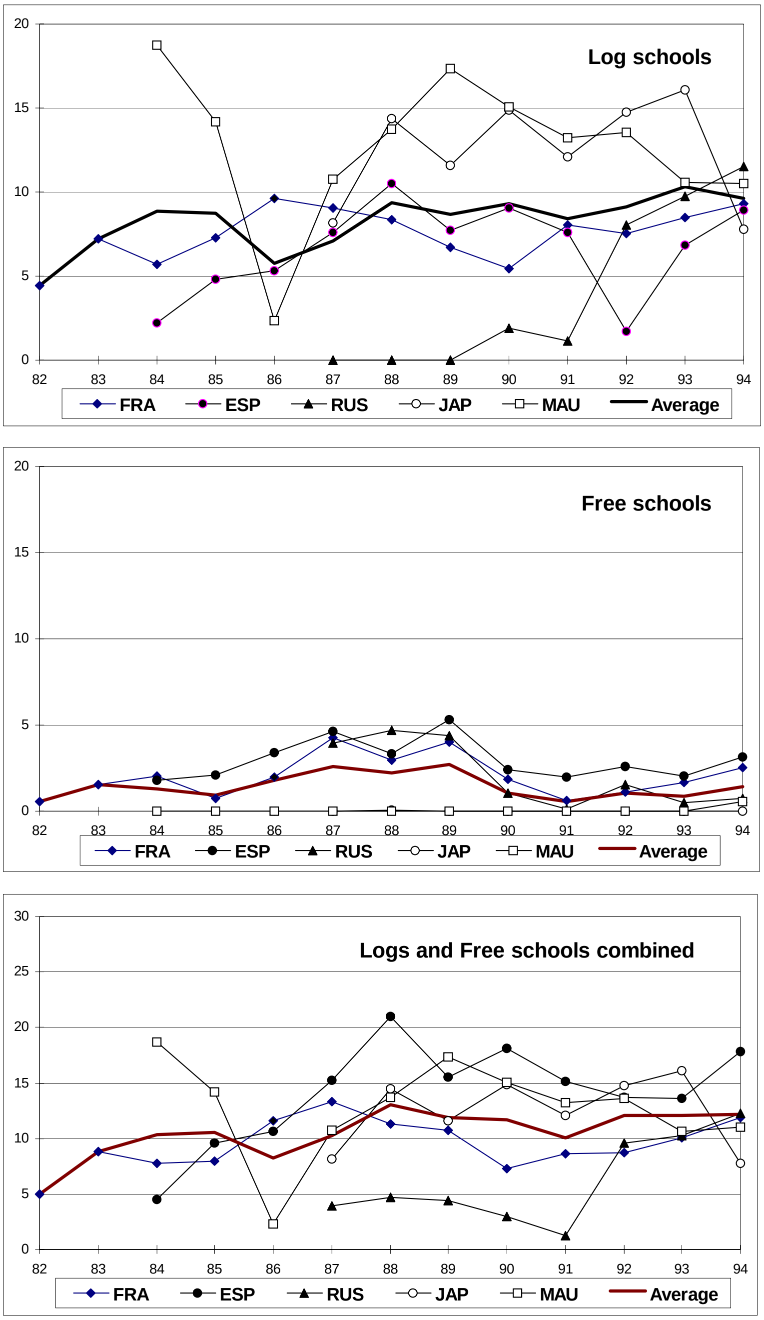

Figure SKJ-3.**CPUE of skipjack tuna (in tonnes per ten searching hours) by purse seine vessels.**

The discrepancy between the catch rate trends in the two fisheries (Maldivian pole-and-line and purse seine) was discussed and several explanations proposed. It was pointed out that, even if the purse seine CPUE trends seem to be more representative of skipjack tuna abundances than of yellowfin tuna abundances, the problems mentioned in the yellowfin section are still pertinent: difficulties in the definition and interpretation of the fishing effort directed at log-associated schools, increase in vessel efficiency, etc.

STATUS OF STOCK

On the basis of available information, the Indian Ocean skipjack tuna stock (considered as unitary) still seems to be in good condition. This opinion is largely based on knowledge of life history and population dynamics of skipjack tuna stocks in other oceans, such as skipjack tuna's ability to reproduce at small sizes (most of the skipjack tuna entering the fishery are mature); its extended spawning area; its high natural mortality rate and rapid turnover rate (as observed in other oceans); and its large population. However, the local decline in catch rates in the Maldives is a cause for concern.

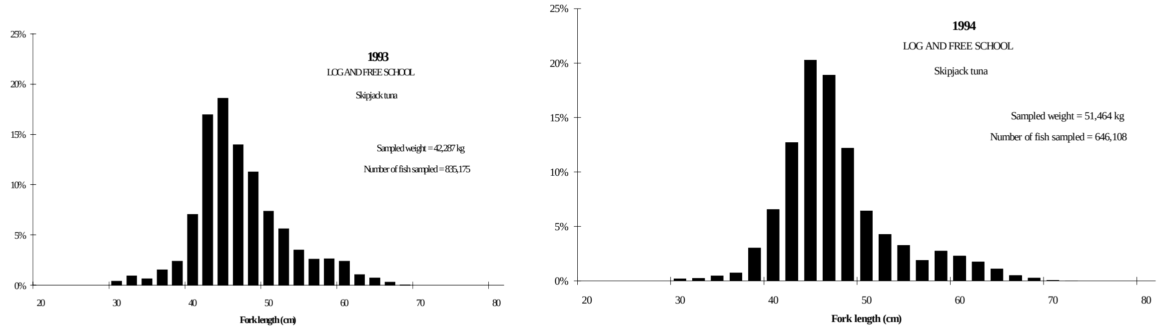

Figure SKJ-4. **Length-frequency distribution of skipjack tuna caught by the Spanish purse seine fleet during 1993 and 1994.**

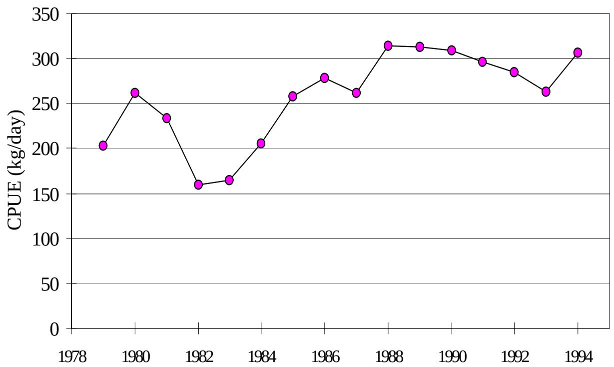

Figure SKJ-5. **Mechanised pole-and-line CPUE for skipjack tuna, 1979-1994, for the entire Maldives (kg/day).**

RECOMMENDATIONS

1. The phenomenon of the recent (1988-1993) decreases in the Maldivian pole-and-line fishery should be further investigated.
2. As for yellowfin, the meaning and interpretation of the purse-seine CPUE (on log, free-swimming or combined schools) and the consequences of the fishing efficiency increase are of utmost importance and should be actively studied.
3. Studies need to be undertaken to obtain accurate estimates of the skipjack tuna growth rate and of its time and space variability.

Albacore

A chart summarising surface and longline albacore catch in the Indian Ocean in recent years was included for reference (Figure ALB-1). The Figure illustrates the fact that while longline catches have remained stable for a long period of time, important catches by surface fisheries occurred in the late 1980's, followed by a decline in the beginning of the 1990's. The gillnet fishery ceased to operate after 1993.

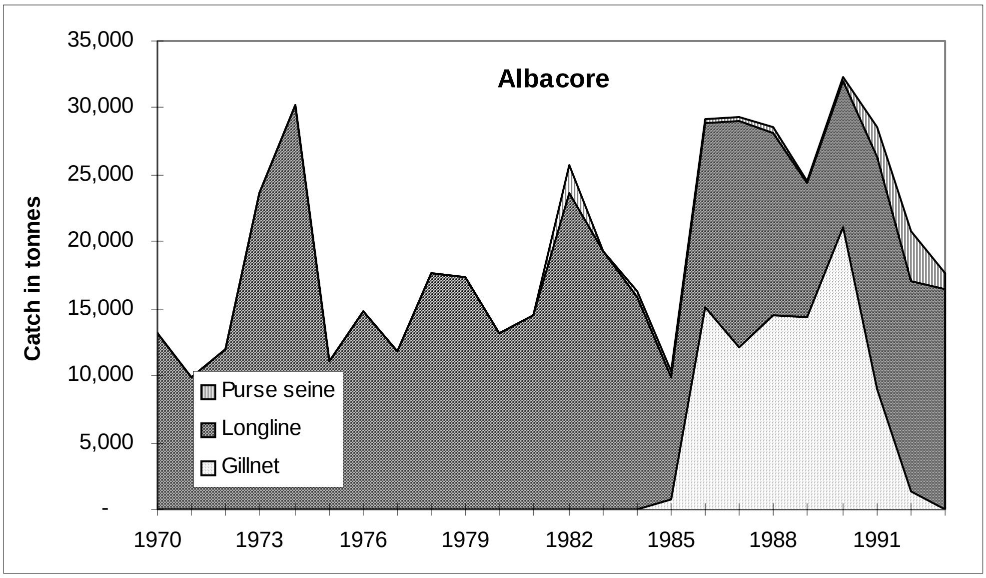

Figure ALB-1. **Catches of albacore by gear.**

RESEARCH ON FISHERIES AND BIOLOGY

Studies of stock structure by morphometric analysis of 144 Indian Ocean albacore from six locations, and DNA sequence analysis of seven specimens from three of the locations, were described (TWS/95/2/25). The resultant stock structure proposed was of two stocks: a western and an eastern Indian Ocean stock, with a separation at about 90^{o}E. During the discussion that followed, it was pointed out that some of the apparent separation in morphometric characters were actually reflecting the differences in size of the fish in the samples analysed. Also, the samples showing strongest divergence of DNA sequence were also those most geographically separate, suggesting the possibility of clinal structure. The patterns of distribution of fishing effort were also mentioned as suggesting the possibility of a north-south, rather than east-west, delineation. Recognising the problems which had existed in obtaining specimens for the study, the meeting was advised that tissue sampling might be feasible as had been done in IPTP collections for the Japan National Research Institute of Far Seas Fisheries. This would provide a basis for further analysis, including review of Atlantic-Indian and Indian-Pacific relationships. Furthermore, some of the samples already analysed by scientists from Japan and Taiwan might usefully be exchanged, given that different analytic techniques were being used. It was recognised that a specially designed spatial sampling design would probably be necessary to evaluate the east-west delineation hypothesis.

ANALYSIS OF STOCK CONDITION

Catch-and-effort data for the Taiwanese longline (1968-1992) and driftnet (1986-1992) fisheries were standardised (TWS/95/2/26) by using general linear models incorporating year, season, area and yellowfin/bigeye target effects. The driftnet series seemed to fluctuate around a long-term average. The longline series tended to increase from 1968 to the early 1980s, declined to the long-term minimum in 1990 then, while still low, was double the 1990 level in 1992. Some reservations were expressed about the CPUE series developed. It was noted that the nominal CPUE data had been aggregated into three large areas reflecting the main regions of the fishery. However, analysis of monthly five-by-five degree cell data would better investigate sensitivity to the fine-scale area information. The high R-square values obtained in the analysis relative to those obtained in similar studies for other fisheries may have resulted *inter-alia* from the aggregation. The analysis indicated significant interactions between year and area, so adoption of a CPUE-by-year time series was insufficient to reflect the interaction identified. Also, tests for interaction using only ANOVA Type III Sum of Squares might not adequately have captured the full effects of the main factors investigated.

The report of the 5th Expert Consultation noted that Taiwan regular longline albacore CPUE had declined considerably since 1986, and that the 1991 catch of 31,400 t was well beyond the historic range of MSY estimates (14,500-22,000 t). However, the dramatic reduction in driftnet fishing had reduced 1992 catch to 17,300 t, which is within the range. Data from the main components of the Indian Ocean albacore fishery, used in a virtual population analysis (VPA) presented at the 5th meeting (TWS/93/2/10), showed a considerable increase in longline CPUE during 1989-91.

A tuned VPA analysis (TWS/95/2/27) used the standardised longline and driftnet CPUE time series of TWS/95/2/26, together with 1980-92 longline and 1986-92 driftnet albacore size-frequency. In tuning, equal weighting was given to the longline and driftnet series. A natural mortality rate of 0.22 was assumed. The analysis indicated eight exploited age groups, with heavy targeting by the driftnet fishery on age 3-4 albacore and broader targeting by the longline fishery on medium-aged and old albacore. Intense operations by the former fishery were found to generate sharp decreases in stock numbers of albacore tuna of ages four and five, one year later. In spite of the closure of the driftnet fishery at the end of 1992, the analysis predicted ongoing low longline CPUEs. This was confirmed in preliminary 1993 CPUE data, but anecdotal reports from fishermen suggested improved CPUEs in 1994 and 1995.

Several uncertainties were raised in relation to the robustness of the analysis to represent the most recent status of the albacore stock. The value assumed for natural mortality rate seemed low relative to the values adopted for other albacore assessments (0.4-0.6), and seemed inconsistent with a longevity of 8 years. Estimated population numbers for younger age classes in the most recent years needed to be treated with caution as they were projections by the model for age classes in incompletely-fished cohorts. Retrospective analyses would be desirable to test the robustness of the model in filling in this sector of the number-at-age matrix. The apparent collapse of recruitment in progress did not appear to be reflected in the fishery data, given the anecdotal indications of reasonable 1994 and 1995 longline catch rates. It is possible that a shift of activity or in size targeted may have contributed to the inconsistency. In addition, the catch-and-effort data might not have been representative.

The data (to 1992) on which the analysis was based would not reflect the final effects of driftnetting which terminated in 1993. That would require several subsequent years of catch-and-effort data. If the analysis predictions represented a real description of the likely short-term future of the stock and recruitment, that would suggest the need for a close-down of fishing. The participants were not convinced that the analysis was sufficiently robust to recommend such action. Nevertheless, they stressed the need for careful monitoring of the Indian Ocean albacore longline fishery catch, effort and size composition over the next several years, and pointed out that a need for urgent action may eventuate if deterioration resumed.

The meeting also noted the existence of a purse seine fishery for albacore in the tropical region of the western Indian Ocean (Figure ALB-2) The fishery is a seasonal one in which tropical tuna purse seiners participate. Catches are being made in areas outside the traditional albacore fishery areas of the longline fleets. The meeting pointed out the need for data routinely collected from this fishery (concerning catches, effort and size-frequencies) be made available to researchers.

STATUS OF THE STOCK

Due to the uncertainties in these analyses available for review by the participants, it was not possible to reach a definitive conclusion on the status of the albacore tuna stock. The participants noted, however, that with the termination of large-scale drifnetting in the Indian Ocean in 1993 and the resulting reduction in catch, the stock should be under less fishing pressure than before. Stock abundance could, therefore, be on an increase. Detection of this response will require a series of several more years of fishery statistics.

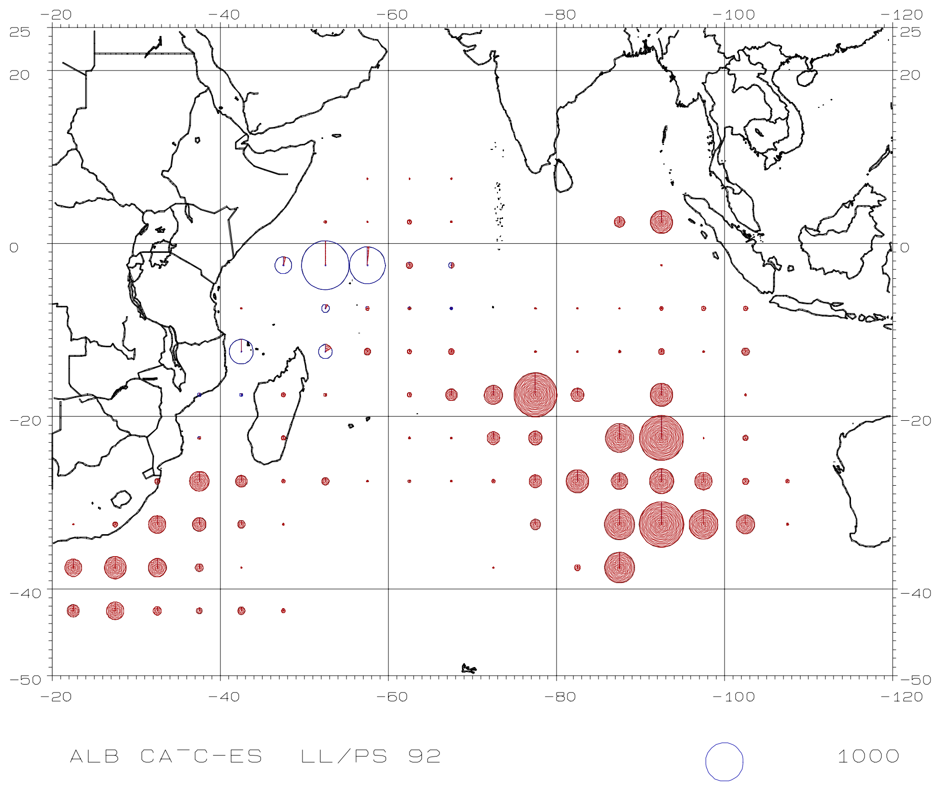

Figure ALB-2. **Spatial distribution of albacore tuna catches during 1992, by purse seiners (empty circles) and longliners (dark circles).**

RECOMMENDATIONS

1. Further work is needed to clarify the question of stock structure. In particular, it remains to be elucidated the question of possible heterogeneity within the Indian Ocean and possible exchanges between the Atlantic and the Indian Oceans.
2. The analyses to obtain the indices of abundance need be redone to take into account significant year-area interactions.
3. Further analyses are needed in relation to the VPA, including retrospective analyses and alternative model structures.
4. The longline fishery catch, effort and size composition needs to be carefully monitored over the next several years.

Southern bluefin tuna

RESEARCH ON FISHERIES AND BIOLOGY

A simulation model was developed (TWS/95/2/29) that assumes an underlying population where a fraction of the stock remains partly unavailable to the fisheries. This concept could explain the abundance of very old (15 to 30 years) southern bluefin tuna recently found in the catches. This hypothesis of a cryptic biomass may be worth considering because of the large area inhabited by southern bluefin tuna and other tuna species. It was concluded that this cryptic biomass could introduce a potential bias in the results obtained from the virtual population analysis conducted on these tuna species, at least for the heavily exploited stocks.

In the ensuing discussion, it was mentioned that the 1994 meeting of the Scientific Committee of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) had considered the “cryptic biomass” and other hypotheses that could explain the large abundance of old fish. Further studies had taken place prior to the 1995 CCSBT Scientific Committee meeting. They had suggested that the most likely explanations are errors in historic catch-at-age data and a capacity to target very effectively on large southern bluefin tuna. In response to a question, it was suggested that surveys or exploratory fishing in spawning areas and tagging in the unfished areas might contribute to assess this hypothesis. In passing, it was pointed out that the "cryptic biomass" hypothesis might prove applicable to other species as well, for example, swordfish.

Some of the research projects being carried out jointly by the Japanese agency JAMARC, and its Australian collaborator, CSIRO, were summarised in an informal presentation to the meeting. One of the main projects aims at obtaining fishery-independent indices of recruitment. Several approaches are being used: aerial surveys applying line-transect sampling; acoustic and troll surveys; and tagging experiments where successive cohorts are tagged in consecutive years. In the case of the aerial surveys, they found that school size and distribution of fish sizes could be determined from the plane, although uncertainties remain with respect to the fraction of the population that is close to the surface. Some results from archival and sonic tagging experiments were presented. Circadian patterns in behaviour are evident from the data, showing vertical movements possibly related to feeding. Two examples of recoveries of archival tags (after a year at liberty) show fish moving to the Indian Ocean and then returning to Australian waters

ANALYSIS OF THE STOCK CONDITION

Recent trends in the Japanese longline catches of southern bluefin tuna were presented (TWS/95/2/28). This species is the one of the highest quality sources for the valuable sashimi market and is currently under management by the CCSBT. The fishery for southern bluefin tuna began in the 1950s and expanded in the 1960s when the catches of the Japanese fleet peaked at 80,000 t. Increases in Japanese effort and in Australian catches during the 1970s led to a quota system that started in the 1980s. During this period, the CPUE of the Japanese fleet was decreasing, while the effort was increasing. In recent times, only the area around Cape of Good Hope was showing good catch rates. The spatial distribution of the effort declined sharply after the introduction of the quota system. Recent nominal CPUE trends by age group showed an increase for ages 3 through 7; a decrease for ages 8 to 11 until 1992 and an increase since then; and stability for ages 12 and older. The indications from the most recent assessments suggest increases of the immature southern bluefin tuna stock in the late 1980s but uncertainty about parental biomass, which may be in the process of increasing or, alternatively at its lowest historical level. Efforts are currently directed towards an improvement of data quality, primarily through implementation of observer programmes and real time monitoring programmes, and towards establishment of a real-time index of recruit abundance.

The Report to the September 1995 CCSBT by its Scientific Committee (TWS/95/2/Inf.1) was available for information. IPTP attended CCSBT as an observer. The Report highlights the controversial nature of the current assessments. As a result of the different interpretations of the assessments, no quota recommendations were formulated pending reconvening of CCSBT in October 1995. The Australian scientists' position is that the uncertainties in the interpretation of most recent CPUE trends for young southern bluefin tuna limit the ability to accurately assess the status of the stock and, therefore, they recommended that a cautious approach to management must be followed. The position of the scientists from New Zealand is that, although there are encouraging signs about the recovery of the population, parental biomass still seems to be very low. They proposed the formulation of a robust mid-term management strategy. The Japanese scientists' position is that there has been a significant rebuilding of the population in recent years and that a rapid increase of parental stock is imminent. They also felt that the current quota constraints, combined with increased CPUEs, limit the acquisition of necessary data to an inadequate sample of time-area strata.

STATUS OF THE STOCK AND RECOMMENDATIONS

Although southern bluefin tuna occurs in the Indian Ocean and, therefore, is one of the species that IPTP is concerned with, current management responsibilities are assumed primarily by CCSBT. For this reason, no specific statements about the status of the stock or recommendations were made for this stock by the Consultation.

Broadbill swordfish

Swordfish is mainly exploited by the Asian longline fleets (China (Taiwan), Japan, Korea). The fishing area covers the whole Indian Ocean: (Figure SWO 1), and high production by longliners is obtained in two subareas of the western region: 1) between 10°N and 10°S, and 2) south of 25°S (Madagascar and South-

Africa). The historical information, starting in 1970, is shown in Figure SWO-2. The general trend of the total production decreased from 1971 to 1973, increased at a slow rate until 1982, and then rose sharply from 1983 to 1992. The latest figures (1992-93) show another sharp increase to about 18,000 t in 1993, due primarily by a large increase in Taiwanese catches. In 1993 as well, a significant amount of swordfish catch was reported from the Sri Lankan gillnet fishery. However, this dramatic increase of gillnet catch is likely due to improved statistical coverage, and not to a real change in fishing strategy or target species.

RESEARCH ON FISHERIES AND BIOLOGY

Recent developments in the longline fishery for swordfish in La Réunion and Seychelles were described (TWS/95/2/32). The fishery in La Réunion started in 1991 with small and mid-size vessels (12 to 33 meters), using the American fishing technique.

The French fleet rapidly increased in size, from one (1991) to 20 boats (1994).The gear used is a monofilament longline, 40 km long. The fishing grounds of the French match those of the Taiwanese fleet. However, two main areas can be distinguished: one stretching 120 miles around Réunion, where the smaller vessels are operating, and a distant area (25°S to 30°S) mostly exploited by the larger vessels. The catches in the southern area are associated with the thermal fronts of the subtropical convergence. Satellite-based sea-surface temperature (SST) maps are distributed to the skippers to enable a better delineation of the water masses and associated fronts.

The sets are made late at night and the line recovered early in the morning. The use of lightsticks is very common, at a rate of one stick every six leaders. The bait used is squid. A shift in target species has occurred with the development of the fishery. In 1992, albacore was the dominant species (40% of the catch), but its importance decreased, while swordfish was becoming the major species (64% in 1994). This shift is mostly due to difficulties met in exporting sashimi-quality tuna, and the good opportunities on American and European markets for swordfish. So far, the best average catch rates (20 fish/1000 hooks) were obtained during the southern winter (May to October).

In the Seychelles, a similar gear as the one employed in the French fishery has been used for 14 experimental surveys, undertaken between March 1994 and March 1995 with the research vessel (18 m long) of the Seychelles Fishing Authority. The deep waters surrounding the central plateau of Seychelles were prospected. Swordfish was the dominant species, followed by yellowfin tuna (22%) and bigeye tuna (17%). This species composition is different from that found in the fishery of La Réunion. The difference is probably due to different temperature stratification between the equatorial system (isotherm 20°C found around 80 m) and the tropical system (20°C at 180 m), the former promoting a better availability of adult tunas in the surface waters. Catch rates have not yet been published.

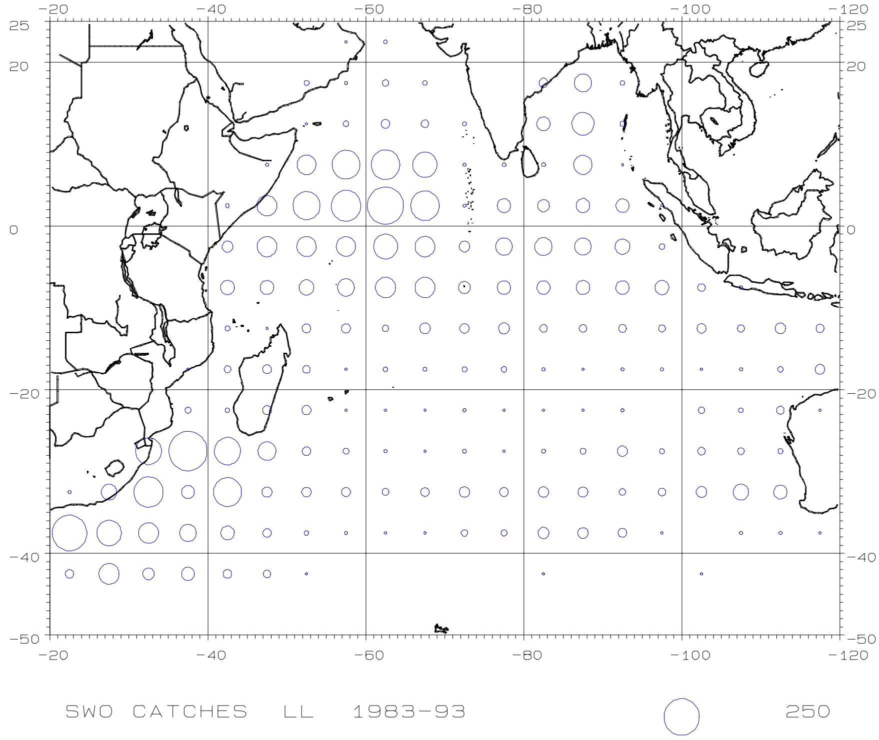

Figure SWO-1. **Average swordfish catches by longline vessels in the Indian Ocean, 1983-1993.**

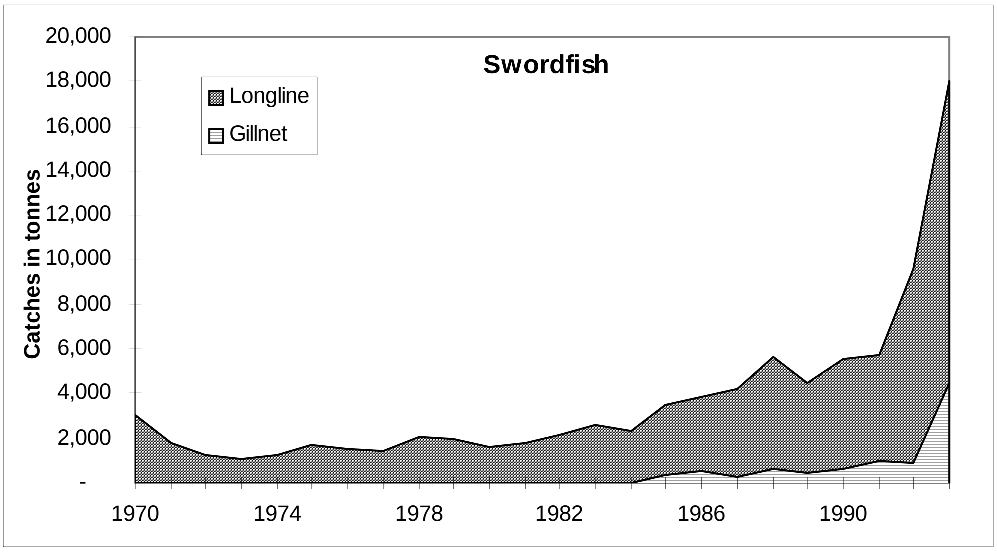

Figure SWO-2. **Recent catches of swordfish in the Indian Ocean by gear.**

An exploratory fishing campaign financed by the European Union was carried out by five Spanish longliners in 1993 and 1994 (TWS/95/1/21). The 10-month survey was in an area between 10°N and 30°S in the western Indian Ocean. The longline was a traditional type, equipped with 1,500 to 2,000 hooks and operating between 5 and 30 meters deep. Swordfish represented 75 to 85% of the catch. The general result was not considered encouraging enough for a further extension of the fishery at the moment. More detailed information should be made available with the publication of a paper that is under preparation.

Both in La Réunion and Seychelles, statistical coverage of the landings and size sampling were implemented from the very beginning of the fishery. The Taiwanese landings are also sampled in size. The log book return rate for French vessels is 95% in La Réunion and 100% in Seychelles (research vessel). The sampling in size points to a striking difference between the two areas, with much smaller fish in Seychelles (average MFL[2]=134 cm) than in Réunion (MFL=165 cm). Comparison with sampling from Sri Lanka (though relevant to another gear) would suggest a dominance of small individuals in the low latitudes, while bigger fish are available in higher latitudes. Similar results from the central and western Pacific were presented at the International Pacific Swordfish Symposium held in Ensenada in December 1994.

Biological samples (2nd anal fin spines) were collected at sea by scientists for ageing purposes. Migration markers were investigated through parasitological study on swordfish. Heart samples were taken for DNA-based analysis for stock identification. Biometric sampling was also undertaken to estimate the relationships between the different standard lengths (PAL[3], EFL[4], CK[5]) and weights (headed and gutted) used on swordfish. This is of key importance for correcting the landings statistics because the fish can be processed in different ways once on board, according to the size and holding capacity of the vessel.

Collection of data on discards was also carried out by observers during the Spanish campaign (its results are not yet published) and on the longliners licensed to fish in the Chagos waters. For the latter, it was mentioned that no discard of billfishes was reported in this area. This potential problem needs special attention as, in some places where the sashimi species are the targets, billfishes discards might be high and may exceed the landed weight.

Other research activities, still underway, aim to a better knowledge of the gear itself, especially the actual depth of the hooks due to oceanic currents and internal waves. The hooks can be affected by ample vertical movements, as was recorded by depth-temperature sensors installed on the line. This high frequency motion might explain a large proportion of the variability in the catches.

A research program involving La Réunion, Seychelles and Spain, with European funding, is under preparation. It is designed to cover four main subjects with emphasis on swordfish:

1. Implementation of a regional longline database
2. Collection of data on biological characteristics of swordfish
3. Study on the relationship between fisheries and the environment
4. Study of socio-economic impact processing and marketing

ANALYSIS OF STOCK CONDITION

No stock assessment has been performed for swordfish in the Indian Ocean. The stock is distributed over a wide geographical area and the catch reported has been at moderate levels until recent years. However, the stock is facing a substantial increase in levels of exploitation. Consequently, the Consultation was concerned that adequate effort is devoted to monitoring the fisheries and to collect relevant data for stock assessment.

STATUS OF THE STOCK

The condition of the swordfish stock is currently unknown. However, the participants noted that given the wide geographical distribution of this species in the Indian Ocean, the moderate level of catch in the past, and the recent presence of a directed fishery for this species, further increased exploitation would likely not adversely affect the health of the stock.

RECOMMENDATIONS

1. Due to the various types of processing to which swordfish catches are subjected, it is necessary to report clearly the type of morphometric measurements taken during size sampling.
2. In order to obtain reliable keys between different lengths and weights used, research on biometric analyses should be continued and extended to all the major landing sites.

[2] MFL = maxillar fork length

[3] PAL = pectoral anal length

[4] EFL = eye fork length

[5] CK = cleithrum keel

Table BIL-1. **Annual catch estimates in the Indian Ocean**

Species	1992	1993
Indo-Pacific Blue Marlin	7,699 t	6,710 t
Black Marlin	2,066 t	3,387 t
Striped Marlin	2,072 t	4,021 t
Indo-Pacific Sailfish	3,278 t	5,139 t
Swordfish	9,630 t	18,042 t
Billfishes NEI	8,865 t	7,700 t
Total Billfishes	33,610 t	44,999 t

Other billfish species

Reported catches of billfishes in the Indian Ocean have increased in recent years to a record 44,999 t in 1993. Major reporting countries include China (Taiwan), India, Japan, Korea, Pakistan, Sri Lanka and Indonesia. Longlines and gillnets are the most important gears. Recent annual catch estimates by species for the entire Indian Ocean are shown in Table BIL-1.

Two papers on the biology and fisheries of Indian Ocean billfishes (other than swordfish) were presented at the Expert Consultation and are summarized below.

The fisheries biology of Indo-Pacific sailfish, *Istiophorus platypterus*, within the Indian EEZ was reviewed in TWS/95/2/30. Over 20% of the total reported Indian Ocean catch of this species was made in Indian waters, mainly by chartered Taiwanese longliners. Regional and seasonal variations in sailfish catch rates and sizes were noted. The highest catch rates were achieved around the Andaman and Nicobar Islands during the 3rd and 4th quarters.

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Billfish landings in Sri Lanka were analysed in TWS/95/2/31. Sri Lankan billfish landings have increased in recent years, in line with the growth of the pelagic fishing fleet, to a record estimated catch of over 13,000 t in 1994. The 1993 catch was 32% of the total recorded Indian Ocean catch of billfishes. Seasonal and regional variations in catch rates by gear type for each species were noted.

The importance (or potential importance) of game fishing was noted in the country reports of Australia (TWS/95/1/22) and Maldives (TWS/95/1/10). Within the Indian Ocean, big-game fishing is also a significant economic activity in Mauritius and South Africa. It was noted that Australian anglers had successfully negotiated restrictions on foreign longliner access to western Australian waters, and that they had been instrumental in obtaining an informal agreement whereby foreign longliners release marlins that are alive at the time of line retrieval (TWS/95/1/22). Some tagging of billfishes by anglers was noted (TWS/95/1/10) and is believed to occur in all game-fishing areas.

STATUS OF STOCKS

No information on the status of billfish stocks was presented. The status of Indian Ocean billfish stocks is unknown.

Table OTT-1. **Annual catches of other tuna in the Indian Ocean**

	1992	1993
Longtail	32,989 t	31,524 t
Frigate and bullet	19,047 t	22,380 t
Kawakawa	54,009 t	54,099 t
Tunas NEI (mostly small spp)	34,660 t	40,318 t

RECOMMENDATIONS

There continues to be a need for billfish fishery statistics to be improved. Particularly:

1. There has been an improvement in the reporting of billfish catches by species (22% of billfish catches in 1993 were not reported by species, compared with 40% in 1989). Nevertheless, there is a need for further improvement and there also appears to be significant under-reporting of billfish catches, and it is recommended that all billfish catches must be reported to IPTP by species.
2. There is significant discarding of billfishes, particularly by high-seas longliners. It is recommended that countries with fleets that discard billfishes obtain full data on these activities and submit them to IPTP in a timely manner.

Other Tuna Species

The most important species of other tunas in Indian Ocean catches are longtail tuna (*Thunnus tonggol*), kawakawa (*Euthynnus affinis),* frigate tuna (*Auxis thazard*) and bullet tuna (*Auxis rochei).* Recent annual catch estimates for the entire Indian Ocean are shown in Table OTT-1.

Three general comments apply to all of these species:

1. Almost the entire Indian Ocean catch is made by coastal countries, notably India, Indonesia, Iran, Maldives, Oman, Pakistan, Sri Lanka, Thailand and UAE.
2. Fisheries statistics are improving but are generally rather poor. In some cases even basic catch information by species is lacking. In many cases detailed catch breakdown by gear and size is lacking.
3. Despite the statistical deficiencies, it is clear that catches of small tunas are significant.

RESEARCH ON FISHERIES AND BIOLOGY

Small tuna catches and catch trends were described in a number of national reports, including those of Iran (TWS/95/1/18), Maldives (TWS/95/1/10), Pakistan (TWS/95/1/20), Sri Lanka (TWS/95/1/12) and Yemen (TWS/95/1/15).

The recently developed ringnet fishery for small tunas in the southern coastal waters of Sri Lanka was reviewed in TWS/95/2/5. This fishery targets small tunas, particularly frigate tuna, but also kawakawa and bullet tuna. Catch rates are much higher for ringnets than for other locally used gears such as gillnets and trolls. The highest catch rates are achieved during April and May. Most of the frigate tuna caught by ringnet off the south coast are mature, while most of those taken off the southwest coast are immature.

Longtail tuna are taken in large quantities in the northern Arabian Sea, notably by Iran, Oman, Pakistan and UAE, as well as by India and Yemen. Recorded catches in this area peaked in 1987-88, and have declined since then. The reasons for this are not known, but may include misreporting of catches in Iran in earlier years. Trends of longtail tuna and kawakawa catches in Iranian waters were examined (TWS/95/1/4) as a possible means of forecasting catches. The most appropriate models for forecasting catch trends were identified. The limitations of this method (i.e. the need to take into account stock status, local fishing effort, and fisheries interactions) were discussed.

An oral presentation was given on the outcome of the joint Gulfs Committee/IPTP Pelagics Working Group meeting held in Bandar Abbas in April 1995. It had been recommended at the Fifth Expert Consultation that such a meeting be convened, and that the status of longtail tuna in the Gulfs and northern Arabian Sea region be reviewed. However, little new information on longtail tuna was presented at that meeting, and no progress was made on stock assessment.

A note on the occurrence of longtail tunas in southern Japanese waters was presented (TWS/95/2/36). Since small juvenile longtail tunas were observed, it was speculated that breeding occurs in this area. A growth rate of about 5-6 cm/month at 18-26 cm was estimated.

STATUS OF STOCKS

No information on the status of "small tuna" stocks was presented. However, the steady decline of reported catches of longtail tuna in the northern Arabian Sea since 1987-88 is noted as a potential cause for concern. Furthermore, a decline in Iranian catches of kawakawa was noted (TWS/95/1/4). Kawakawa catches of Oman have also declined. This too is a potential cause for concern. However, in the absence of more detailed information, stock assessment for longtail tuna and kawakawa could not be carried out and no management recommendations are made.

RECOMMENDATIONS

1. As reported at the Fifth Expert Consultation, there continues to be a need for small tuna fishery statistics to be improved. A first priority is that all catches must be reported to IPTP by species, not by species group. A second priority remains the collection of the associated effort data.

2. As recommended by the Fifth Expert Consultation, there was a need to consolidate the understanding of the biology of kawakawa and longtail tuna. In particular, age validation, reproduction and migration studies were required. Little progress has been made, so this recommendation is retained.

Seerfish

A major fishery exists for seerfishes, mainly narrow-barred Spanish mackerel (*Scomberomorus commerson*), in the northern Arabian Sea and the Gulfs. Some recent work carried out on that fishery was reviewed, but no other new information on Indian Ocean seerfishes was presented. In Figure KGX-1, the trend of the catch of seerfish in the western Indian Ocean indicate a decline in catches after 1988 that caused concern about the status of exploitation of the stock.

RESEARCH ON FISHERIES AND BIOLOGY

A review on the biology of *Scomberomorus* and *Acanthocybium* species was presented in TWS/95/2/Inf.2, as well as a status paper on Narrow-barred Spanish mackerel (*S. commerson*) in TWS/95/2/34. Until recently, the economic contribution of the narrow-barred Spanish mackerel resource to the national income in Oman exceeded that of all other fisheries. General background information was given on migration pattern, spawning, stock structure, growth, and the fishery of this species.

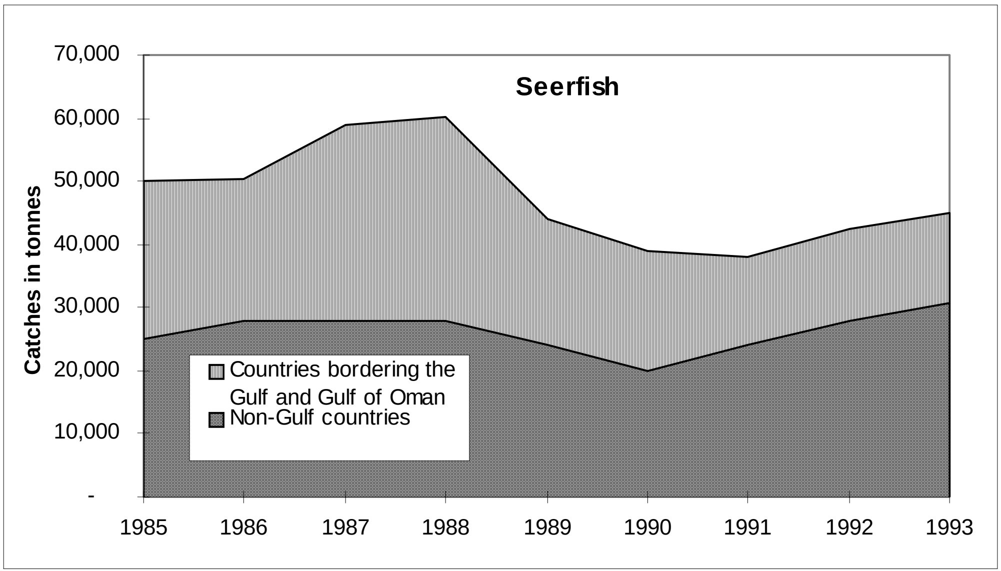

Figure KGX-1. **Catches of seerfish in FAO Area 51.**

The sharp decrease of the catches in Oman is a major concern of fishery managers (Figure KGX-1). Furthermore, the Omani status paper indicates that the large catches of small individuals could lead to the reduction of the parental stock to a level that could cause a recruitment failure. At the same time, the appearance of a large number of recruits in 1993 may indicate the appearance of a strong year-class.

The catch trend of the Omani narrow-barred Spanish mackerel fishery does not appear in catch statistics from neighbouring countries. This could possibly be the consequence of the Omani fishery exploiting a stock shared with only the United Arab Emirates (UAE) fishery. The Omani fishery exploits both large and small individuals and the recent catches have tended to be of smaller fish. The UAE fishery, on the other hand, is mainly for small individuals.

The two papers also presented a review of available biological data and recommend further biological and statistical studies, a freeze on increase of fishing effort and measures to increase the size of first capture.

ANALYSIS OF THE STOCK CONDITION

During the ensuing discussion, the participants were informed that the possibility of the downward trend of Omani catches being due to problems in the statistical system has been firmly refuted by Omani scientists. The Omani statistical catch series start in 1985 and one study, presented at the last IPTP Tuna Expert Consultation, attributed the high catches in 1987 and 1988 to particular strong year classes. Other analyses, undertaken by Omani scientists, put the stock in a heavy to very heavy state of exploitation.

Previous tuna workshops proposed that a working group on seerfish and longtail tuna be organised by IPTP. The meeting was informed that IPTP has contacted all the countries concerned and visited some of them to ascertain the interest of the countries of the region to take part in the working group. Missions findings indicate that the available data do not permit the assessment of the stocks of seerfish and longtail tuna. Biological and statistical data collection has improved in two countries and only moderate interest has been shown in the creation of a working group

In April 1995, IPTP has co-sponsored the first meeting of the Working Group on Pelagics of the Gulfs Committee. Unfortunately this meeting was attended by only four countries. The Working Group recommended that biological data collection be improved and extended to all fishing areas in the different countries and that catch and effort data collection be improved. Other recommendations concerned the need to study gear selectivity and suggested a number of studies to be undertaken.

Status of the stock

No new information was discussed at this meeting. The following was taken from TWS/95/2/Inf.2. *Scomberomorus commerson* is the only seerfish species for which stock assessment has been undertaken. There have been several studies undertaken on the Omani fishery. The results suggest that effort is near or above the optimal level, and that biomass and/or catch would be increased by increasing size at first capture.

A study of the Persian/Arabian Gulf stock of *S.commerson* (off the Saudi Arabian coast) suggested that the level of exploitation was close to optimal. Another study from 1987 in Saudi Arabia suggested that the Red Sea stock was not overexploited.

Recommendations

1. Collection of biological data should be improved and extended to all fishing areas.
2. Estimated growth rates of *S. commerson*, in particular, need to be validated.
3. Catch-and-effort data collection must be improved.
4. There is a need for a study on gear selectivity.

Agenda Item 3 : Tagging studies

Three papers were presented under this agenda, tagging activities in the Maldives, analysis of tag recoveries in Mauritius, and the report of the Yellowfin Tagging Work Group.

The main objectives of the present Maldivian tagging project (TWS/95/3/1), relevant to the former tagging experiment carried out in 1990, are:

1. Tag skipjack inshore and offshore to elucidate possible differences in behaviour.
2. Study the effect of the SW and NE monsoon seasons.
3. Improve the accuracy of the information returned.
4. Effect OTC-tagging of skipjack and yellowfin

A preliminary analysis of the recovery data show different results from the previous tagging experiment with regard to inshore/offshore behaviour. Previously, it was observed that skipjack tagged inshore were usually recovered inshore, and that the probability of more extensive movement was higher in skipjack tagged offshore. The present results indicate the opposite. This difference in results may be due to the great variation in recovery rates from different tagging trips (i.e. differences between inshore and offshore are not significant). Another possible explanation could be that the area defined as an offshore area (Sathoraha seamount) is part of the Maldivian geological structure. A third explanation relates to size. As skipjack of 50 to 55 cm are under-represented in the Maldivian fishery, it was hypothesised that migration is predominant in this size range. Certainly, these are the sizes that are caught in the Sri Lankan fishery. An attempt should be made on targeting this size range in future tagging, although they are not readily available. The experiment also aimed at testing several assumptions related to tagging and tag loss.

Growth estimates for yellowfin, bigeye, and skipjack tunas based on a relatively small sample number of returns recovered in Mauritius and a description of the codification procedure in use were provided in TWS/95/3/2. Migration patterns of some fish could also be traced, although the small number of recoveries do not allow definite conclusions. It was proposed that tracks of other recaptured fishes should be included in the chart of movements. The number of negative growth results was high in this study, and it was pointed out that elimination of these observations was not correct procedure in estimating growth. Consequently, this data set should not be used for growth estimates.

At the 1991 IPTP Workshop on Stock Assessment of Yellowfin Tuna, it was recommended that all data on tag recoveries be sent to the IPTP database. At present, only the Maldives has sent all the information relevant to tagging.

Following the recommendations of the 5th Consultation, a working group was convened to review the existing proposals for a large-scale programme for tagging yellowfin tuna. The Report of this group was introduced for consideration by the Consultation (TWS/95/3/3).

Regarding the objectives of the tagging programme, the group concluded that one of the main priorities mentioned in previous proposals, the assessment of the yellowfin stock structure in the entire Indian Ocean, cannot be achieved by tagging in the western Indian Ocean alone. This would require tagging yellowfin tuna in the eastern Indian Ocean as well, in order to assess exchange rates between the two basins. This is not possible because of a number of logistical constraints. The group considered that independent genetic studies could contribute in the understanding of stock structure.

Assessing small-scale stock structure, as recommended by the 5th Expert Consultation, was considered a viable objective for a tagging experiment from which movement rates could be estimated. Similarly, the group considered that the relationship between fish associated in different school types could be clarified from tagging data. The group also agreed that validation of growth and ageing procedure could be best obtained from recoveries of OTC-injected fish. For both purposes, the group recommends the release of yellowfin tuna of a wide range of sizes, to allow for analysis that would incorporate size-dependency.

The existing guidelines recommended assessment of fishery interactions as a second priority. The group agreed about the importance of this objective. It noted that, to reduce possible uncertainties, tagging in different fisheries would be required, as well as tagging a large range of sizes of fish.

The group recommended that, to consider these revised objectives when planning the large-scale tagging programme, more information was needed. In particular, extended simulation analyses were mentioned, along with a number of pilot studies with the purpose of assessing the feasibility of tagging yellowfin tuna from alternative platforms. The following three pilot studies (listed in order of priority) were identified as important first steps:

- A pilot tagging study in a coastal artisanal fishery (Oman, handline and troll fisheries) (investigating feasibility in a non pole-and-line vessel situation).
- A pilot tagging experiment from a longline vessel (India/ Seychelles) (feasibility of tagging large longline-caught yellowfin tuna).
- A pilot tagging experiment from a purse-seine vessel (Mauritius/ Iran) (feasibility of purse-seine releases, should a large pole-and-line vessel be unavailable).

The objectives of these pilot studies are to assess feasibility, train personnel and estimate costs, estimate local recovery rates, and release tetracycline-injected fish for growth studies. The tagging projects in the Maldives are examples of successfully executed experiments.

It would be necessary for the relevant authorities and agencies to commit manpower for publicity and follow-up, apart from the actual tagging itself. It will also be of crucial importance that accurate data on catch, effort and lengths be available during the tagging and for a minimum of at least two years after completion of tagging. Funding for such a large-scale tagging experiment could be sought in the European Union context, but this would only be realistic upon the formation of the IOTC. Carrying out successful pilot studies would point to the feasibility of such a large-scale tagging programme. Such pilot studies leading up to the main programme might be funded by IPTP[6], if the present level of member country contributions are maintained.

Possible industrial type vessels that could be used for the programme were discussed, although contact with owners of private vessels has not yet been made. This included two longline research vessels, one in Seychelles and one in India, one state-owned purse seiner in Iran, and one private purse seiner in Mauritius. Another possibility of tagging in an artisanal fishery would be the artisanal pole-and-line fishery of the Laccadives.

The possibility of expanding the area of the proposal to include the eastern Indian Ocean was brought up. In the first instance, the guidelines that had been set in the Yellowfin workshop in 1991 restricted the study area to the western Indian Ocean, which is based on the assumption that management issues were most likely to arise there because of the rapidly increasing catches. Extension of the tagging programme to Area 57 was not thought feasible due to the major increase in funding that would require, the scarcity of baiting areas and to the relative lack of surface fisheries for the recapture of tagged fish. Co-operation of all countries will however be important in the tagging programme and any stock structure studies.

The conduct of a major publicity campaign, in connection with tagging, was regarded as extremely important in creating awareness for the study in the industrial fleets of Spain, Korea, Japan, Taiwan, and France and the canneries, besides the fishermen involved in the artisanal fisheries. Initially, a product-flow analysis would be a useful tool in clarifying the movement of the landings to where processing occurs, thus identifying clearly where publicity has a priority. In the case of the Japanese longliners, a major publicity campaign has been carried out by the Japan Tuna Association to obtain recoveries of southern bluefin tags. A similar approach could be used for the purpose of publicising yellowfin tagging (as was the case for the licensed Korean longliners), although the Japanese fleet targets southern bluefin primarily. Another approach might be a requirement to give a commitment to undertake tagging when applying for a fishing licence. Furthermore, the FAO Fisheries Information Service has been publishing InfoFish, InfoPesca, GlobeFish, etc. and their good contacts to the fishing industry could be used for publicity on the tagging study.

In conclusion, the revised recommendations were accepted and these are:

1. Accept the revised objectives and general approach to the Large-Scale Yellowfin Tagging Programme as developed by the working group.

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[6] This is a matter to be further discussed during the Tripartite Review Meeting.

2. Subject to the availability of funds, implement pilot studies and simulation studies as possible to facilitate the planning of the Large-Scale Yellowfin Tagging Programme

Agenda Item 4 : *Progress made in Data Collection Systems*

In opening this agenda item, the IPTP Programme Co-ordinator pointed out that all countries present at the meeting had been requested to prepare a detailed description of their tuna statistical systems. Unfortunately, there has been a poor response to this request. The meeting recommended that all countries catching tuna and tuna-like species in the Indian Ocean should submit this information in a written format in order to ascertain the quality of the data.

The status of data collection in Sri Lanka was described in TWS/95/4/1. Two independent statistical systems exist, one run by the Ministry of Fisheries and Aquatic Resources and a second one, particularly aimed at small and large pelagic fisheries, run by NARA.

Data collection by the Ministry started in 1970. The quality of this system has gradually been eroded. The present tuna statistics are produced through the NARA survey. In 1994, NARA took over and strengthened the IPTP tuna sampling programme. Catch and effort data collection now covers most of the main tuna landing points. A logbook system has been introduced to collect information from the fast developing small scale offshore fishery. No logbook system exists for the collection of data from the industrial longliners based in Colombo, but remedial action should be taken soon.

NARA has undertaken tuna research for several years and this includes studies in fish biology and gear technology and the development of Fish Aggregating Devices. An offshore research survey has been initiated which is aimed at improving fishing techniques and acquiring scientific information on the offshore tuna resources in the Sri Lankan EEZ.

The status of tuna research and data collection in the Maldives was presented in TWS/95/4/2. The Maldives has a well established tuna catch and effort statistical system based on total enumeration of the catch. In each inhabited island, all tuna landings are reported to the island chief by species, in numbers, and the catch in weight is calculated using conversion factors. In practice some underreporting is suspected (around 5% for skipjack and 15% for yellowfin). Steps are being taken to correct this problem. Effort is reported in boat-days.

Length-frequency sampling has recently been greatly expanded, with a length-frequency sampling throughout the country since 1993. These data have allowed the calculation of more reliable conversion factors to transform catch numbers into weight. The Maldivian tuna statistics are considered to be accurate, with data series going back 25 years. These data, by atoll and by month, have been provided to IPTP.

Foreign purse seine vessels tranship their catches in the south of the Maldives. Arrangements should be made to sample these transhipments. Licences given to longliners to fish in the Maldivian EEZ have been cancelled as a consequence of poor logbook reporting.

The meeting noted that the Maldivian system also provides spatial information as the boats from each atoll exploit a particular fishing area. The timely production of statistical reports and the publication of a newsletter provides an important feedback to the industry.

The tuna statistic procedures of Taiwanese longline and gillnet fisheries in the Indian Ocean were presented in TWS/95/4/4. Data collection for longliners started in 1967, while gillnet data are available for the period 1986 to 1992, when this fishery ceased operating.

Taiwanese longliners provide logbook information on return to their home port. After verification, the available logbook data are used to build five-by-five degree catch-and-effort statistics using raising factors calculated from daily radio reports on fishing effort. Length measurements of the first 30 fish caught are collected on board by the fishermen, although these data are not always reliable. Port sampling is undertaken when the vessels return to the home port. Gillnet boats were sampled on landing as most of their trips ended in Taiwan.

Municipal authorities are responsible for statistical reporting on vessels of less than 100 GRT, but these do not regularly report their catches. The catch of large longliners, working under joint venture or other arrangements with Indian Ocean countries, may have been reported both by the coastal country and by Taiwan. The Taiwanese delegates requested that coastal countries should communicate the list of longliners landing in the Indian Ocean to Taiwan through IPTP so that double- or non- reporting can be minimised.

The IPTP Programme Manager informed the meeting that IPTP staff is visiting countries where landings by foreign longliners take place to initiate arrangements for the creation of a database of longliners active in the region.

The meeting recommended that all countries report transhipment information to IPTP for all industrial tuna fishing vessels. Where possible, vessels should be identified using their International Radio Call Sign, Lloyd's number and the national boat registration number. At present, only Mauritius is providing transhipment information, but vessels are identified by name. During the discussions it was pointed out that transhipment information would also allow the estimation of catches by vessels under flags of convenience.

IFREMER and SFA indicated that they presently hold a vessel database covering industrial longline vessels. The countries of the *Commission de l'Ocean Indien* (COI) exchange information in view of creating a regional list of longliners. Both sources of information can be made available to IPTP.

The Indian delegate informed IPTP that the list of longliners fishing in India (all under Honduras flag) can be made available to IPTP with details of radio call sign and registration number.

The delegate from the United Kingdom informed the participants that a database containing a list of some 110 longliners that have been registered to fish in the waters covered by the British-Mauritian Fishery Commission will be provided to IPTP. The British-Mauritian Fisheries Commission covers the Chagos waters (British Indian Ocean Territory) for purposes of conservations of fishery resources.

A document (TWS/95/4/7) was presented, that detailed the statistical procedures used to sample industrial purse seiners landing in the countries of the *Association Thonière* and in Mombasa (Kenya). Logbook data are collected when the purse seiners come to port. Transhipment or landing information is used to correct logbook estimates.

In all harbours, species composition and length-frequency samples are taken from the catch. Samples are taken from wells with catches coming from homogeneous time and area strata (generally 1 degree square by fortnight). These samples allow the correction of the species distribution of the catch given in the logbooks.

Data are pre-coded and entered on computer using a standard software package written by ORSTOM. The countries of the COI compare their databases, once a year, to prevent duplication of data. ORSTOM uses these data to produce yearly catch estimates and catch-and-effort databases. Monthly catch-and-effort and extrapolated size composition on a five-by-five degree basis are then supplied to IPTP, identifying log and free-swimming schools.

This statistical system covers most of the Indian Ocean harbours used for transhipment by purse seiners. The totality of French purse seiners and the majority of the other fleets are covered by this sampling scheme. The Spanish purse seine fleet is covered by a similar, independent system.

During the discussion, the level of accuracy of the databases necessary to allow pertinent scientific analysis was discussed. Although it will be the responsibility of IOTC to define its rules regarding this topic, the Consultation recommended strongly that monthly, one-by-one degree catch-and-effort data and monthly, five-by-five degree square size composition should be considered as the standard for all fisheries.

Further comments were made on the necessity of standardising effort units or clearly defining the effort units used when data are provided to IPTP. It was concluded, however, that it would be difficult to correct time series if there were a change in effort units and that it was therefore preferable to collect effort information in the standard unit of effort used by the organisation supplying the data. It was recommended that all the information concerning the units of effort used in those statistics should be provided to IPTP.

A detailed revision of purse seiner catch-and-effort historical series as well as extrapolated size composition is underway. A detailed evaluation study of the statistical procedures used to sample and process data from purse seine vessels will be financed by the European Union next year. It will most probably lead to new estimates of the catch and size composition.

A newly developed computer package to extract catch data series from a world wide database on tuna catches, TUCAW, was presented. It was suggested that this package could be of interest to a large number of users and might therefore be finalised and maintained by an international organisation.

WINTUNA, a programme for the storage, maintenance and processing of longline and purse seine logbook and transhipment data, was then presented by IPTP. The software has been developed for use by coastal countries to handle logbook data from both foreign and local industrial fisheries. This software has a series of in-built controls that limit input errors and facilitate data entry. A wide range of reports and maps allow separate output of either general or restricted information such as licences and catch in the EEZ. Other options allow the preparation of catch-and-effort and transhipment reports for IPTP. The software uses transhipment and port sampling information to correct estimated logbook catches. Graphic routines provide a presentation of fishing positions and catch-and-effort information and allow queries of particular fishing operations. It was noted that attention to documentation of the system would be important in view of the forthcoming departure of its developer.

A catalogue of catch, catch-and-effort and length-frequency data available in the IPTP databases was then presented. Countries were requested to compare these data with available national data so that missing information could be sent to IPTP. At present, only few countries have provided length-frequency data, and catch-and-effort information for important sections of the longline fleet are missing. The meeting recommended that member countries provide the full range of data normally requested by IPTP, including nominal catches by gear, fleet statistics, catch-and-effort data, length frequencies and transhipment information.

IPTP informed the delegates that a new version of the TUNASTAT package is now available. This software is used to distribute the IPTP nominal catch database in electronic format. Also, the Atlas of tuna resources in the Indian Ocean produced by IPTP was introduced. The Consultation recognised its importance and commended IPTP for the quality of the publication. It was noted, however, that users should always bear in mind that gaps still remained in the data on which it was based. In case of staff movements, the importance of having enough resources for maintaining and documenting the databases and software produced by IPTP was stressed.

The problem of late submission of data by member countries was then discussed. It was suggested that, ideally, scientists attending the regular IPTP Expert Consultations should bring the latest statistical data from their countries. This might be encouraged if a routine statistical meeting preceded Consultations.

The problem of data aggregation was also noted, with artisanal statistical systems often grouping several tuna species and gears. Furthermore, these systems rarely provide fishing locations. This is a particularly serious problem now that in many countries the fishing boats venture further off-shore. The necessity of introducing logbook data collection systems was pointed out. It is known that 500 to 600 longliners landing in Indonesia and some 150 similar vessels in Oman are not covered by any logbook system.

A discussion on by-catch and discards also established that longliners under the British Indian Ocean Territory management regime (covering the Chagos waters) carry some observers. The data on by-catch and discards, as well as length-frequencies, will be provided to IPTP. In Sri Lanka, a port sampling scheme will cover longliners which are thought to land all the catch, including sharks. This will provide comparative data on components which are normally discarded in sashimi fisheries.

It was indicated that Australia conducts an observer programme aboard Japanese longline vessels in the Australian 200-nautical-mile fishing zone. Catch species composition, as well as discard details, are collected routinely. There is also some size-composition data available in relation to the by-catch.

The report of the first International Workshop on Albatross-Fisheries Interactions (TWS/95/2/Inf 3) was distributed for information. The Consultation noted that this had particular relevance in relation to longlining, and especially longlining in temperate regions.

Agenda Item 5: *Any other Matters, Conclusions and Recommendations*

General

It was recognised that this Expert Consultation is perhaps the last such meeting before the formal creation of the Indian Ocean Tuna Commission (IOTC). However, some time will be required for IOTC to become fully operational. In particular, the establishment of the scale of contributions and the choice of a location of headquarters for IOTC need to be determined and funds must be secured for its operation. There was a consensus that, during that time, IPTP must continue its role in the region, anticipating future needs of IOTC, including those for improving the quality of fishery data, information on the biology and status of stocks and fisheries management advice. In addition, IPTP would have to provide Secretariat support to the Commission until this body is fully operational.

More emphasis needs to be placed on the determination of status of stocks and the provision of fisheries management advice, as this will be essential for IOTC to become effective. The Consultation agreed that this can be best achieved by the formation of working groups to assess the status of some main stocks. The recommendations of the Yellowfin Tagging Working Group regarding pilot tagging experiments were also noted.

It was recognised that an increased level of financial support for IPTP will be necessary to fully carry out the above-mentioned activities. If this increase is not possible at this stage, the present funding should be maintained to at least partially execute the additional activities required. Therefore, the participants recommended that:

I. FAO and UNDP should, until the proposed Indian Ocean Tuna Commission becomes fully operational, ensure the continued operation of IPTP with sufficient personnel and operational funds for the conduct of its activities in:

- **A. Co-ordination and support of data collection, and maintenance of an ocean-wide database on fishery statistics;**
- **B. Co-ordination of biological and stock assessment research;**
- **C. Assistance to developing countries in data collection and research.**

Statistics

During the discussion of this subject, the question of acquisition of adequate fishery statistics was recognised as being of paramount importance for stock assessment. Consequently, it is necessary to remind member countries of the importance on timeliness and accuracy in the submission of data. It was felt by the Secretariat that the question of submitting the data in IPTP formats should not be mandatory if this would cause delays.

The Secretariat also reported that IPTP has contributed to the design and implementation of national tuna sampling schemes, but that IPTP has to eventually transfer control of these programmes to the respective countries. The case of Sri Lanka was mentioned as an example of a successful transfer.

The Secretariat reported that it has implemented a revision of the statistical areas, as recommended by the previous Consultation. These revisions have been made in coordination with ICCAT and SPC, so that there is no overlap in the statistical areas of the three organizations.

In the previous Consultation, there was a specific recommendation calling for the compilation by IPTP of statistics on by-catch and accidental catches of non-tuna species. The Secretariat reported that appropriate forms were sent to the fishing nations but that there has been no reply thus far. Therefore, this still represents an unresolved problem. It was suggested that the previous recommendation be extended to include a request for information on discards. It was recognised that reliable information on this subject is very difficult to obtain, and that an observer program might be the only way to proceed. However, it was also noted that some progress has been achieved, since the proposed sampling programme in Sri Lanka and the observer schemes in Chagos and Australia might provide some information.

It was suggested that each country appoint a data correspondent who would liaise with IPTP regarding the compilation of data. The secretariat noted that such focal points already exist, and that it might be just a matter of confirming with each government whether the designated person is also appropriate in relation to data issues. It was also suggested that the participants to the next meeting should be required to bring the required information with them. Another suggestion was to address the specific question of data submission through a separate working group that would meet prior to the next meeting.

Taking these considerations into account, the participants agreed to the following recommendations:

I. All countries fishing for tuna and tuna-like species in the Indian Ocean should provide IPTP, in a timely manner, with the full range of data normally requested, including:

- **A. Nominal catches by gear, as disaggregated as possible.**
- **B. Catch-and-effort data by gear, as disaggregated as possible. For surface fisheries, the data should be provided to IPTP at a one-degree spatial resolution.**
- **C. Updated length-frequency data on the major tuna and tuna-like species as dissagregated as possible. For surface fisheries, the data should be provided as monthly fork-length distributions at a five-degree spatial resolution.**
- **D. Transhipment data by foreign vessels, providing details on how this information was generated. Where possible, vessels should be identified using their International Radio Call Sign, Lloyd's number and the national boat registration number.**
- **E. Available data on by-catch and discards, including those of sharks and non-tuna species.**

In addition, all countries should ensure that data provided to IPTP conform to the standards contained in the Appendix V of the Report of the Workshop on Yellowfin Tuna held in Colombo, Sri Lanka in 1991.

II. All countries fishing for tuna and tuna-like species in the Indian Ocean should submit a detailed description of their tuna statistical systems, in a written format, in order to ascertain the quality of the data.

III. IPTP should be provided with the necessary funds and personnel to design and operate tuna sampling schemes in those countries where national statistics do not provide suitable information on tuna fishing.

IV. The countries in which tuna sampling programmes are organised should take the necessary steps to take over these sampling schemes after the first year of full implementation.

V. FAO should examine the possibility, in relation with the countries directly concerned, of revising Area 51 and 57 boundaries.

Tagging

The participants accepted the revised objectives and general approach to the large-scale Yellowfin Tagging Programme developed by the *ad-hoc* Working Group and, therefore, recommended that:

1. **In order to facilitate planning for the large-scale yellowfin tagging experiment, subject to the availability of funds, tagging pilot studies and simulation studies be implemented, with the objectives listed in the Report of the Yellowfin Tagging Working Group.**

Stock assessment

There was extensive discussion on how to actually implement working groups on stock assessment and which should be the stocks with the highest priority. It was recognised that, ideally, stock assessments should be carried out at regular intervals and that the IPTP/ IOTC Secretariat should convene working groups as necessary. Such groups would also serve as sources of motivation and as a way to identify research needs.

However, it was also acknowledged that the Secretariat might lack the necessary funds to carry out such a task for all species. It was also pointed out that perhaps stock assessments were not needed every year for every stock. Since it became clear that it would not be possible to deal with all the species at the same level of detail, it was agreed that it was necessary to identify priority stocks. Progress in the research on different stocks should be followed by mail, and working groups should be convened as identified by the programme. In particular, the need for a working group, on seerfish and longtail was reaffirmed, perhaps on a sub-regional basis.

The participants took note that

I. Large, uncontrolled increases in fishing effort should be avoided, in particular when the status of the stocks is uncertain.

The participants also agreed that recent research highlighted the importance of environmental factors in the understanding of fisheries in the Indian Ocean and, therefore, recommended that:

II. The integration of environmental parameters in the assessment of tuna stocks should be encouraged since the Indian Ocean is affected by significant oceanographic variability.

The following are the specific research recommendations for each of the stocks considered during the Consultation:

YELLOWFIN TUNA

I. Further studies are needed to adjust current indices of abundance from purse-seine vessels to account for recent increases in fishing efficiency.

II. The data necessary for analysis using age-structured models should be reviewed and further analyses should be carried out as soon as possible on the revised data assemblages.

III. In the eastern Indian Ocean, an improvement in collection and reporting of fisheries statistics and biological information is required to develop a reliable index of abundance for the region.

BIGEYE TUNA

I. Information concerning indices of abundance and the age structure of the catches should be compiled for carrying out a VPA analysis.

SKIPJACK TUNA

I. The recent decreases in catch rates and average size of fish in the Maldivian pole-and-line fishery should be further investigated.

II. As for yellowfin, the meaning and interpretation of the purse-seine CPUE (on log, free-swimming or combined schools) and the consequences of the fishing efficiency increase are of utmost importance and should be actively studied.

III. **Studies need to be undertaken to obtain accurate estimates of skipjack tuna growth rates and their temporal and spatial variability.**

ALBACORE TUNA

I. Further work is needed to clarify the question of stock structure.

II. Current indices of abundance need to be further developed to take into account significant year-area interactions.

III. **Further analyses are needed in relation to the VPA, including retrospective analyses and the application of alternative model structures.**

IV. The longline-fishery catch, effort and size composition needs to be carefully monitored over the next several years.

BROADBILL SWORDFISH

I. Due to the various types of processing to which swordfish catches are subjected, it is necessary to report clearly the type of morphometric measurements taken during size sampling.

II. In order to obtain reliable keys between different lengths and weights used, research on biometric analyses should be continued and extended to all the major landing sites.

OTHER BILLFISH SPECIES

I. Billfish fishery statistics still need to be improved and, in particular, catches must be reported to IPTP in full by species.

II. Countries with fleets that discard billfishes should obtain full data on these activities, and submit them to IPTP in a timely manner.

OTHER TUNA SPECIES

I. There continues to be a need for small tuna fishery statistics to be improved. A first priority is that all catches must be reported to IPTP by species, not by species group. A second priority remains the collection of associated effort data.

II. Age validation, reproduction and migration studies are still required for kawakawa and longtail tuna.

SEERFISH

I. Collection of biological data should be improved and extended to all fishing areas.

II. Estimated growth rates of *S. commerson*, in particular, need to be validated.

III. Catch-and-effort data collection must be improved.

IV. There is a need for a study on gear selectivity.

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Appendix II: *Papers presented to the 6th Expert Consultation on Indian Ocean Tunas*

Agenda Item 1: Review of National Fisheries

Somvanshi,V.S. and M.E.John, *Oceanic Tuna Fishery in India - an update*,TWS/95/1/1

Gafa, B., and J.C.B. Uktolseja, *Country Report of Indonesian Tuna Fisheries in the Indian Ocean*,TWS/95/1/3

Kaymaram, F. and D. Rostami, *Forecasting and Management of Artisanal Tuna Fisheries by the Use of Time Series in Iranian Waters*,TWS/95/1/4

Okamoto, H. and N. Miyabe, *Review of Japanese Tuna Fishery in the Indian Ocean*,TWS/95/1/6

Rabenomanana, L. D. and F. Gilbert, *Situation de la Pêche Thonière à Madagascar*,TWS/95/1/8

Mohd Ali, B.B., *Indian Ocean Tuna Landings by Foreign Vessels in Malaysia*,TWS/95/1/9

Anderson, R.C., A. Hafiz and S. Adam, *Review of the Maldivian Tuna Fishery*,TWS/95/1/10

Munbodh, M., *Country Report - Mauritius*,TWS/95/1/11

Dayaratne, P. and R. Maldeniya, *Recent Trends in the Tuna Fisheries in Sri Lanka*,TWS/95/1/12

Huang, Hong-Yen, *National Report of 1994. Taiwanese Longline Fisheries in the Indian Ocean*,TWS/95/1/13

Saeed, S.S., *Biology and Status of Tuna in Yemen*, TWS/95/1/15

Pearce, J., *A Review of the British Indian Ocean Territory Fisheries Conservation and Management Zone Tuna Fishery 1991-1995*,TWS/95/1/17

Kaymaram, F., *National Report of the Islamic Republic of Iran*,TWS/95/1/18

Majid, A., *Tuna Production in Pakistan in Recent Years*,TWS/95/1/20

Moron, J., *National Report of Spain*,TWS/95/1/21

Caton, A. and P. Ward. *Fisheries for Tunas and Tuna-like Species in the Western Region of the Australian Fishing Zone*,TWS/95/1/22

Moon, Dae-Yeon and Choong Shin Oh, *National Report of Korea*,TWS/95/1/23

Hastings, R.E and G. Domingue, *Recent Trends in the Seychelles Industrial Fishery*,TWS/95/1/24

René, F., A. Legroux and F. Poisson, *Recent Evolution of La Réunion Fisheries Sector*,TWS/95/1/25

Agenda Item 2: Review of Status of Stocks and Tuna Biology

Fonteneau, A., *Preliminary Comparative Overview of the Environment and of the Tuna Fisheries Catching Yellowfin, Skipjack and Bigeye, and Operating in the Atlantic, Indian and Pacific Oceans*, TWS/95/2/1

Petit, M., X. Bernardet, F. Poisson, E.Tessier and F. Rene, *Implementation of Space Time Data Base Between Environment and Fisheries on Daily Basis*,TWS/95/2/2

Venkatasami, A. and A. Sheik Mamode, *Fish Aggregating Devices (FADs) as a Tool to Enhance Production of Artisanal Fishermen - Problems and Perspectives*,TWS/95/2/3

Maldeniya, R., *Small Boat Tuna Longline Fishery in North-West Coast of Sri Lanka,*TWS/95/2/4

Maldeniya, R. and P.Dayaratne, *A Recently Developed Ringnet Fishery for Small Tunas in the Southern Coastal Waters of Sri Lanka*,TWS/95/2/5

Shoughi, H., *Study of the Genetic Maturity of Tuna Species in Cistan-Baluchistan Province Coastlines*,TWS/95/2/6

John, M.E., *Some Observations on the Role of Thermal Processes in the Distribution of Yellowfin Tuna in Longline Fishing.*,TWS/95/2/7

Marsac, F., *ENSO-related Events in the Indian Ocean with Emphasis on Yellowfin Tuna CPUEs*,TWS/95/2/8

Adam, M.S. and R.C. Anderson, *Yellowfin Tuna (Thunnus albacares) in the Maldives*,TWS/95/2/9

Marsac, F., P. Cayré and F. Conand, *Analysis of Small Scale Movements of Yellowfin Tuna around FADs Using Sonic Tagging,*TWS/95/2/10

Norungee, D., and C. Lim Shung, *Analysis of the Purse-seine Fishery of Mauritius (1990-1994) and the Comparison of Catch Rate and Species Composition of Catches of Mauritian Purse-Seiners to those of the French Fleet,*TWS/95/2/11

Nishida, T., *Preliminary Resource Assessment of Yellowfin Tuna (Thunnus albacares) in the Western Indian Ocean by the Stock Fishery Dynamic Model*,TWS/95/2/13

Nishida, T., *Influence of Purse-Seine Fisheries on Longline Fisheries for Yellowfin Tuna (Thunnus albacares) in the Western Indian Ocean*,TWS/95/2/14

Uktolseja, J.C.B., *Distribution of Hook-Rate of Longline Fishery for Yellowfin and Bigeye Tuna by 5º area in the Indian Ocean, 1978-1990*,TWS/95/2/15

Anderson, R.C., *Bigeye Tuna (Thunnus obesus) in the Maldives*,TWS/95/2/16

Okamoto, H. and N. Miyabe, *Updated Standardized CPUE Caught by the Japanese Longline Fishery in the Indian Ocean, and Stock Assessment by Production Model*,TWS/95/2/17

Adam, M.S. and R.C. Anderson, *Skipjack Tuna (Katsuwonus pelamis) in the Maldives*,TWS/95/2/18

Puwasasmita, R., and J.C.B. Uktolseja Suprapto, *Preliminary Report on Stock Identification of Skipjack Tuna from Padang, West Sumatra and Pelabuhan Ratu, West Java, Indian Ocean, based on Analysis of Protein Electrophoresis*,TWS/95/2/19

Romanov, E.V., V.V. Korkosh and M.V. Smirnov, *Age and Growth of Indian Ocean Skipjack Tuna (Katsuwonus pelamis, Linnaeus, 1758) Based on Counting Growth Marks on Cross Section of the First Dorsal Fin Spine*,TWS/95/2/20

Adam, M.S., B. Stequert and R.C. Anderson, *Irregular Microincrement Deposition on the Otoliths of Skipjack Tuna (Katsuwonus pelamis) from the Maldives*,TWS/95/2/21

Stequert, B. and B. Ramcharrun, *Fecundity of Skipjack Tuna (Katsuwonus pelamis) from the Western Indian Ocean*,TWS/95/2/22

Stequert, B. and B. Ramcharrun, *Sexual Cycle of Skipjack Tuna (Katsuwonus pelamis) from the Western Indian Ocean*,TWS/95/2/23

Timohina, O.I. and E. V. Romanov, *Characteristics of Ovogenesis and Some Data on Maturation and Spawning of Skipjack Tuna (Katsuwonus pelamis, Linnaeus, 1758) from the Western Part of the Equatorial Zone of the Indian Ocean,*TWS/95/2/24

Yeh, Shean-Ya, Cho-Fat Hui, Trong-Der Treng and Chin-Lou Koa, *Indian Albacore Stock Structure Studies by Morphometric and DNA Sequence Methods*,TWS/95/2/25

Chang, Shui-Kai and Hsi-Chiang Liu, *Adjusted Indian Albacore CPUE Series of Taiwanese Longline and Driftnet Fisheries*,TWS/95/2/26

Lee, Ying-Chou and Hsi-Chiang Liu, *An Updated Virtual Population Analysis of Indian Albacore stock, 1980-1992*,TWS/95/2/27

Nishida, T., *Trends of Japanese Longline Fisheries for Southern Bluefin Tuna (Thunnus maccoyii)*,TWS/95/2/28

Fonteneau, A., *Why So Many Very Old Fishes in the Southern Bluefin Catches? Preliminary Modelling of the "Cryptic" Biomass Hypothesis*,TWS/95/2/29

John, M.E., A.K. Bhargava, V.Rane and A.S. Kadam, *Some Aspects on the Distribution and Biology of the Indo-Pacific Sailfish, Istiophorus platypterus, (Shaw and Nodder, 1792) in Indian waters*,TWS/95/2/30

Maldeniya, R., P.Dayaratne and D. Amarasooriya, *An Analysis of Billfish Landings in the Pelagic Fisheries in Sri Lanka*, TWS/95/2/31

Poisson, F, G. Domingue, P. Michaud and F. Rene, *Premiers Résultats de la Campagne de pêche à la Palangre Dérivante Ciblant L'espadon aux Accores du Plateau Seychellois; Comparaison avec les Résultats Obtenus avec les Mêmes Techniques aux Accores de La Réunion*,TWS/95/2/32

Pillai, N.G.K., *Assessment of the Stock of Kingseer Scomberomorus commerson (Lac.) Along the West Coast of India*,TWS/95/2/33

Kingfish Task Force, *Status of the Kingfish Resource and Fisheries in the Sultanate of Oman*,TWS/95/2/34

Itoh, T., S. Tsuji and S. Chow, *Catch Information of Longtail Tuna, Thunnus tonggol, in Japan*,TWS/95/2/35

Anon, *Report of the first meeting of the Scientific Committee of the Commission for the Conservation of Southern Bluefin Tuna*,TWS/95/2/Inf.1

Siddeek, M.S.M., *Review of Fisheries Biology of Scomberomorus and Acanthocybium Species in the Western Indian Ocean (FAO Area 51*),TWS/95/2/Inf.2

Anon, *The first International Workshop on Albatross-fisheries Interactions*,TWS/95/2/Inf.3

Agenda Item 3 : Tagging studies

Anderson, R.C., M.S.Adam and A. Waheed, *Tuna Tagging Activities in the Maldives, 1993-95*,TWS/95/3/1

Cayré, P., D. Norungee & C. Lim Shung, *Analysis of Tag Recoveries in Mauritius (1988-1993) and Presentation of Codification Procedure in Use*,TWS/95/3/2

Anon, *Report of the Yellowfin Tagging Working Group*,TWS/95/3/3

Agenda Item 4 : Progress made in Data Collection Systems

Dayaratne, P. and R. Maldeniya, *Status Report on the Development of Tuna Research and Data Collection*,TWS/95/4/1

Anderson, R.C. and A. Hafiz, *Status of Tuna Research and Data Collection in the Maldives*,TWS/95/4/2

Lee, Ying-Chou and Hsi-Chiang Liu, *The Tuna Statistics Procedures of Taiwanese Longline and Gillnet Fisheries in the Indian Ocean*,TWS/95/4/4

Nordstrom, U.V. and A. Fonteneau, *TUCAW (Tuna Catch Worldwide), A Data Base and Software (User Friendly) Developed to Analyse the Yearly Tuna Catches Worldwide (by Species, Gear, Country and Oceanic Area)*,TWS/95/4/5

Carrara, G., *WINTUNA - Computer Programme for Entry and Reporting of Tuna Purse Seine and Longline Logbook Data (Verbal Presentation)*,TWS/95/4/6

Thomas, A, O. Dufour, R. Pianet and J. Morón, *Data Recording System and Sample Strategy in the Western Indian Ocean Purse-Seine Fishery*,TWS/95/4/7

Anon, *Catalog of the Databases Available at IPTP*,TWS/95/4/Inf.1

Appendix IV:

Report of the Working Group on the Yellowfin Tuna Tagging Programme

BACKGROUND

After the increase in fishing pressure on the yellowfin tuna resource in the Indian Ocean in recent years and, in particular, after the large increase in industrial fishing in the region, concerns were raised about the need for a comprehensive assessment of the effects of such increases on the productivity of the resource and the development of potential interactions amongst the fisheries involved.

It soon became apparent that more information about the resource characteristics would be needed before a reliable assessment could be carried out, and that a large-scale tagging experiment would the most effective way to reduce the existing uncertainties. This realisation prompted recommendations from several IPTP workshops calling for such a project.

In particular, the 1991 Workshop on Stock Assessment of Yellowfin Tuna in the Indian Ocean produced a set of general guidelines regarding its objectives. These objectives were re-affirmed during the 5th Expert Consultation on Indian Ocean Tunas, where a specific proposal for a tagging program was presented. This proposal called for a one-year tagging effort with a target number of releases of 10,000 individuals, primarily in the area of operations of the industrial purse-seine fishery.

Since the last Consultation, more information has been made available on tagging techniques and on the resource and, for this reason, this was perceived as a good opportunity to revisit those proposals. Therefore, a meeting of a small Working Group was convened, prior to the beginning of this Consultation, with the objective of re-examine the characteristics of current proposals and, if possible, to establish general guidelines for an action plan that would allow to obtain the information required for a sound management of the yellowfin resource.

OBJECTIVES

The 1991 Workshop recommended that obtaining information about the stock structure and on biological parameters should be the first priority for the experiment, followed in importance by the assessment of potential fishery interactions. With respect to the question of stock structure, the Group noted that the 1991 Workshop guidelines suggest that the general area of operation must be the area west of 80 degrees E (FAO area 51). Under this constraint, it is unlikely that the information provided by a tagging experiment would be sufficient to discriminate between the current hypotheses regarding stock structure. In particular, the question about the relationship, if any, between the Western and Eastern Indian Ocean portions of the yellowfin resource would remain unresolved. The group also noted that estimating rates of exchange of individuals between both basins remains an important question for a proper assessment of the resource. However, this would require the simultaneous tagging of large numbers of fish in both areas of the Indian Ocean, something that would require a substantially larger effort and that it might prove unfeasible given operational constraints. The Group considered that independent studies, such as genetic analyses (in particular, micro-satellite DNA), might contribute to clarify the stock structure although these techniques might still lack the resolution necessary to provide precise assessment of exchange rates.

The Report of the 5th Expert Consultation recommended focusing the attention on the small-scale sub-stock structure, which the Group considered that could be partly addressed by obtaining estimates of movement rates (and, therefore, residence times) in different areas of the Western Indian Ocean. The Group also interpreted the question of small-scale structure as including the relationship among the different school types encountered in the region (schools associated with seamounts, in association with floating objects, or free-swimming schools), as well as the relationship between the fractions of the resource available to the surface and longline fleets. There was a consensus in the Group that these questions could be adequately answered by tagging experiment. However, the Group also agreed that, since the available data indicate that these features might be related to size (and that movement rates might be different for different size-based categories), it will necessary to tag fish over a large range of sizes and from different types of schools.

Regarding the second aspect of the first priority, biological parameters, the Group noted that one of the most important question for stock assessment is to confirm whether rings in otoliths are formed with a certain regularity. This can be achieved by tetracycline injections in tagged fish. The Group also noted that the first steps towards reaching this objective have been taken by experiments currently underway, such as the tagging of yellowfin injected with tetracycline being carried out by the Maldives. In any case, there is little doubt that this is an objective achievable even with a relatively number of tagged fish. To assess possible heterogeneities in growth rates, it would preferable to release tetracycline-marked fish from different locations.

With respect to the second priority, assessing the extent of resource-mediated interactions between fisheries, the Group reached a consensus that tagging in all fisheries that are potentially interacting is the best way to proceed, as it was suggested by simulation studies. As before, the Group considered that extending the tagging over a large range of sizes would help in determining whether there the interactions are size-dependent. The Group also noted that tagging from longliners could help in resolving the question of why the tags recovered from longline fleets are usually lower than expected. It was also mentioned that the opportunistic tagging of bigeye could also be useful in this respect.

It was also agreed that given some of the complexities involved in the problem, it might difficult, at the moment, to assess whether the proposed number of releases would be sufficient for the intended objectives. To better assess this number, it was recommended that the previous simulation analyses be extended to incorporate size structure in the simulated population and to examine the effect of alternative tagging strategies (such as different locations and sizes of releases) on the ability to estimate the relevant parameters.

LOGISTIC CONSIDERATIONS

From the considerations of the previous section, it became clear that, for a tagging program to meet the proposed goals, it would have to include tagging from different platforms, both to ensure the coverage of different areas and fisheries and the availability of fish of different sizes. However, there is little prior experience of tagging from certain platforms in the Indian Ocean. Baitboats have been the preferred option, in particular for tagging small and medium-sized fish. It was also noted that the availability of bait might be less of a problem than previously thought. However, concerns were expressed with regard to the trend in the numbers of baitboats in the region which might hamper our ability to find a suitable boat for the execution of the experiment. This fact reinforces the need for considering alternative platforms.

This lead to a discussion about the difficulties encountered when tagging from those alternative platforms. It was agreed that in most cases, it will be necessary to carry out pilot studies before the actual planning of any large-scale experiment. In this respect, a pilot study to assess the feasibility to tag from coastal artisanal fisheries was identified as of high priority. For this study, Oman was mentioned as a possible study area. Purse-seiners were mentioned as an alternative for obtaining medium-size and large fish. However, uncertainties remain with respect to the feasibility of tagging from purse-seiners, because fish are subject to additional handling stress. Some successful examples were mentioned, in particular, tagging done from Japanese purse-seiners and, also, in the Western Pacific, where the additional vessels assist during the tagging to reduce operational problems. It was also noted that better results could be achieved if the size of the tagged fish was not directly measured (thus reducing the handling time) but estimated from a sample of fish from the same set. In the Indian Ocean, there is the difficulty of the large operating costs of the vessels from EC countries, although the possibility exists of using vessels from some of the nations of the region. In any case, there was a consensus in the Group that a feasibility study was necessary. A similar conclusion was reached for the case of longliners, where some of the possibilities include utilizing vessels from India or Seychelles.

To summarise, the following three pilot studies (listed in order of priority) were identified as important first steps:

- A pilot tagging study in a coastal artisanal fishery.
- A pilot tagging experiment from a longline vessel.
- A pilot tagging experiment from a purse-seine vessel.

The objectives of these studies are:

- Assess feasibility.
- Training of personnel and estimating costs.
- Release tetracycline-inject fish for growth studies.
- Estimating local recovery rates.

The Group felt that these studies should be viewed as part of a long-term strategy designed to provide essential information for the stock assessment of the yellowfin resource. As such, they become the critical first steps that could and need to be taken in the near future, in order to successfully plan and execute the major tagging programme.

This brought up the problem of finding the funds require to carry out such strategy. Until IOTC becomes operational, it is unlikely that a major external source of funding could be secure. This suggests that funding for the final tagging programme might not be available for the next three to four years. However, the cost of the initial stages (the pilot studies) is much lower and funding by IPTP is a possibility. In that case, it would be necessary to extend the responsibilities of IPTP to include the execution of the pilot studies and to ensure that the present level of contribution by the member countries is maintained.

Another problem discussed by the Group was the necessity of good information on catches, effort and length distributions from all the fisheries involved for a period of at least two years following the major release of tagged fish. It was stressed that this is an essential piece of information to correctly interpret the pattern of recoveries. As a possibility, it was suggested that additional sampling schemes could be implemented and that, in that case, any necessary extra funds required must be included in the costs of the large tagging experiment. Special encouragement must be given to countries to implement logbook programs that could improve the quality of the information.

The Group stressed the need for incorporating in the larger tagging programme, experiments oriented towards validation of some of the assumptions implicit in tagging studies. In particular, double tagging and tag seeding must be carried out when feasible.

The possibility of non-traditional tagging was mentioned. The Group felt that, while there are some interesting advances in the area of archival tagging, the technology still needs more development. In any case, the group felt that the information provided by archival tags might complement, but not necessarily replaced, the information obtained through a good conventional tagging programme.

CONCLUSIONS AND RECOMMENDATIONS:

1. The objective of clarifying large-scale stock structure is not achievable from a viable tagging programme.
2. The objective of estimating movement rates, that could be useful to determine small-scale stock structure in the Western Indian Ocean, as well as obtaining information about biological parameters and fisheries interactions can be met with a regional tagging programme.
3. This programme needs to include tagging from different platforms and of different sizes of fish.
4. In order to improve the chances of success, feasibility studies and simulation studies need to be carried out as the first stage of the a long-term strategy leading to the planning and execution of the large tagging experiment

Appendix V: *Agenda of the Meeting*

Monday 25 September

Opening Ceremony

Adoption of the Agenda and Arrangements for the Meeting

Agenda Item 1: *Review of National Fisheries*

Agenda Item 1: (Continued)

Agenda Item 1: (Continued)

Tuesday 26 September

Agenda Item 2: *Review of Status of Stocks and Tuna Biology*

Agenda Item 2: (General; Yellowfin)

Agenda Item 2: (Yellowfin)

Agenda Item 2: (Yellowfin; Bigeye)

Wednesday 27 September

Agenda Item 2: (Bigeye; Skipjack)

Agenda Item 2: (Skipjack, Albacore)

Agenda Item 2: (Albacore, Southern Bluefin, Billfishes)

Agenda Item 2: (Southern Bluefin, Billfishes, Small Tuna)

Thursday 28 September

Agenda Item 3: *Tagging Studies*

Agenda Item 4: *Progress made in Data Collection Systems*

Agenda Item 4: (Continued)

Agenda Item 5: *Any other Matters, Conclusions and Recommendations*

Friday 29 September

Presentation of the Report

Adoption of the Report

Appendix VI: ***Publications of the Indo-Pacific Tuna Development and Management Programme*.**

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